Annual Report of the State Board of Forestry

Indiana State Board of Forestry

Unnecessary waste in a natural forest. Large white oak which has blown over and been left to rot.

STATE OF INDIANA

FOURTEENTH ANNUAL REPORT

OF THE

State Board of Forestry

1914

ELIJAH A. GLADDEN
SECRETARY

TO THE GOVERNOR

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING
1915

THE STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
December 15, 1914.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF THE AUDITOR OF STATE,
INDIANAPOLIS, December 16, 1914.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

DALE J. CRITTENBERGER,
Auditor of State.

JANUARY 5, 1915.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

B. B. JOHNSON,
Secretary to the Governor.

Filed in the office of the Secretary of State of the State of Indiana, January 5, 1915.

HOMER L. COOK,
Secretary of State.

Received the within report and delivered to the printer, January 5, 1915.

ED D. DONNELL,
Clerk Printing Board.

Letter of Transmittal.

INDIANA STATE BOARD OF FORESTRY,

INDIANAPOLIS, INDIANA, December 15, 1914.

Hon. Samuel M. Ralston:

SIR—As required by Section 4 of the Act establishing a State Board of Forestry, approved March 1, 1901, we submit herewith the Fourteenth Annual Report of the Board of Forestry, beginning with October 1, 1913, and ending with September 30, 1914.

Very respectfully,

W. A. GUTHRIE, President.

ELIJAH A. GLADDEN, Secretary.

Indiana State Board of Forestry.

OFFICIAL MEMBERS, 1914.

WM. A. GUTHRIE, President.....Indianapolis
STANLEY COULTER.....Lafayette
CURTIS D. MEEKER.....Monticello
WILLIAM C. GOBLE.....Nashville
ELIJAH A. GLADDEN, Secretary.....Scottsburg
EMMA L. STREIBICH, Stenographer.....Indianapolis

OFFICE OF SECRETARY.

Room 110, State House, Indianapolis.

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Financial Statement.

OCTOBER 1, 1913, TO SEPTEMBER 30, 1914.

Annual Appropriation by the General Assembly, 1913.

1. Office—		
Salary of secretary of board	$1,800 00	
Salary of stenographer to secretary	720 00	
Salary of four board members	400 00	
Mileage expenses of four board members	120 48	
General office expense and mileage	1,000 00	
		$4,040 48
2. Forest Reservation and Experimental Station		3,000 00
3. Specific—Woodlot investigations and exhibit		1,000 00
Total appropriations		$8,040 48

Expenditures.

Office—Salaries:		
Elijah A. Gladden, secretary of board	$1,800 00	
Emma Streibich, stenographer to secretary	720 00	
W. A. Guthrie, board member	100 00	
W. A. Guthrie, mileage and traveling expenses	10 27	
Stanley Coulter, board member	100 00	
Stanley Coulter, mileage and traveling expenses	13 00	
Curtis D. Meeker, board member	100 00	
Curtis D. Meeker, mileage and traveling expenses	45 96	
William C. Goble, board member	100 00	
William C. Goble, mileage and traveling expenses	51 25	
		$3,040 48
Office—General Expense:		
Printing and office supplies	$186 39	
Mileage and hotel expenses	103 12	
Postage	337 00	
Express and freight	18 43	
Telephone	52 25	
Photographic supplies	6 35	
Prizes	80 00	
Subscriptions	8 65	
		$792 19

Reservation Expense—		
Salaries, custodian and teamster	$1,260 00	
Labor	486 66	
Household supplies	6 60	
Implements, hardware, paints and oils	103 97	
Seedlings and seed	116 56	
Construction material	77 50	
For cistern, and drilling wells	361 75	
Mules and harness	379 45	
Carbide	15 00	
Fertilizer	60 13	
Feed	29 40	
Blacksmithing	10 25	
Board for board members	17 00	
Telephone	25 60	
Express and freight	25 42	
Mileage	2 80	
Livery	18 50	
Postage	2 00	
		$2,998 59
Specific—		
Preparing exhibit for State Fair, etc		239 25
Total expenditures		$7.070 51
Receipts from sales at Forest Reservation and Experimental Station and remitted to State Treasurer upon recommendation of State Auditor		$218 50

Introduction.

It is certainly time for Indiana to take an inventory of her forests and see what can be done in the way of reforestation before it is too late.

The student of history will recall that a large part of Palestine, China, Persia and other oriental countries were once covered with vast forests, but the destroying hand of man has not only changed the forests, but has thereby changed the entire economic condition of those lands, from one of fruitfulness to one of barrenness. If the destruction keeps up for the next hundred years as it has in the past century, Indiana will be in much the same condition as the oriental countries named.

The people who settled Indiana found it occupied by axless savages who were either killed or driven away from this land by them, and then they proceeded to lay waste the forests that had sheltered them, and with unremitting toil the forests of Indiana, that then seemed inexhaustible, have been reduced to mere woodlots in most parts of the State.

In traveling over many parts of Indiana, one is caused to wonder why many tracts of land are not reforested instead of being left in a denuded state, and then the thought comes to us that a change can be made, that it must be done, and that it will be done. Why should a tract of land fitted by nature to produce a vast forest, to be a thing of beauty, an heritage to the people, be left a waste for more than a hundred years with only a few huts that can scarcely be called homes, when by an effort on the part of the State all this land could again be reforested and be made to return to its original state, and retained in that condition indefinitely by using the timber as it matured.

It has been proven that a forest, to yield the greatest and best amount of timber, should not be destroyed by cutting the entire forest at stated times, but should be thinned by removing all inferior trees and those that have come to full maturity. When this is done other trees should be planted to take their places and a continuous system of reforestation followed. And we would again affirm the belief that the State should take the lead in the work of

reforestation by furnishing trees at cost to those that would take up the work and follow the directions of the Board of Forestry as to the kinds of trees that should be planted in each particular community and on the kinds of soil fitted for the various kinds of trees.

The Board has carried on experiments on the Forest Reserve for several years and is now ready to furnish statements as to the proper method of planting and cultivating the trees, pruning, thinning, and the average growth of many species of Indiana, thus saving to the individual the cost of making these experiments.

What we need more than any other one thing in forestry is the coöperation of the owners of woodlots in this work of reforestation, and we believe the time will soon come when all will understand that the trees are a necessary part of every community, for the trees use up the carbon dioxide in the air and restore it back again in the form of oxygen, the element that all must have or perish. If we believe this (and I think most of us do), then let us renew our efforts to have trees of some kind on every acre of land not fitted for agriculture.

If you are not convinced that a grove of white ash, black locust, white oak, walnut, chestnut, tulip or some one of the many kinds of trees that grow well in Indiana, will not yield you a profit on your investment, then try the apple, peach, pear or some of the fruit trees that would do so well on the denuded hills of our State, and not blame a generation that has preceded us for the destruction of the forests, for would you, my friend, have done differently if you had lived in the times and environments as they; for is there not some truth in the trite saying, "that all men do the best they can all things considered", and "some live in the past, some anticipate the future, but all must use the present".

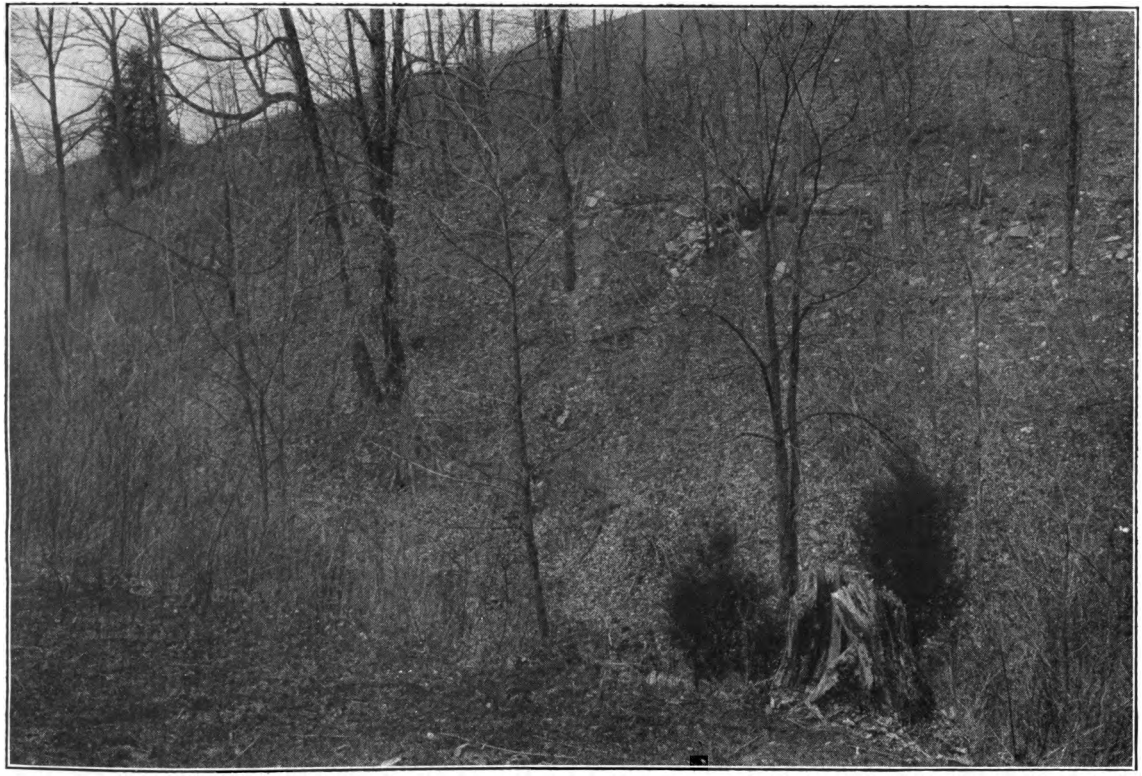


PLATE 2. Young trees preventing erosion in non-agricultural land.

PLATE 3. Young trees growing on land that is very rough and unfit for any other purpose.

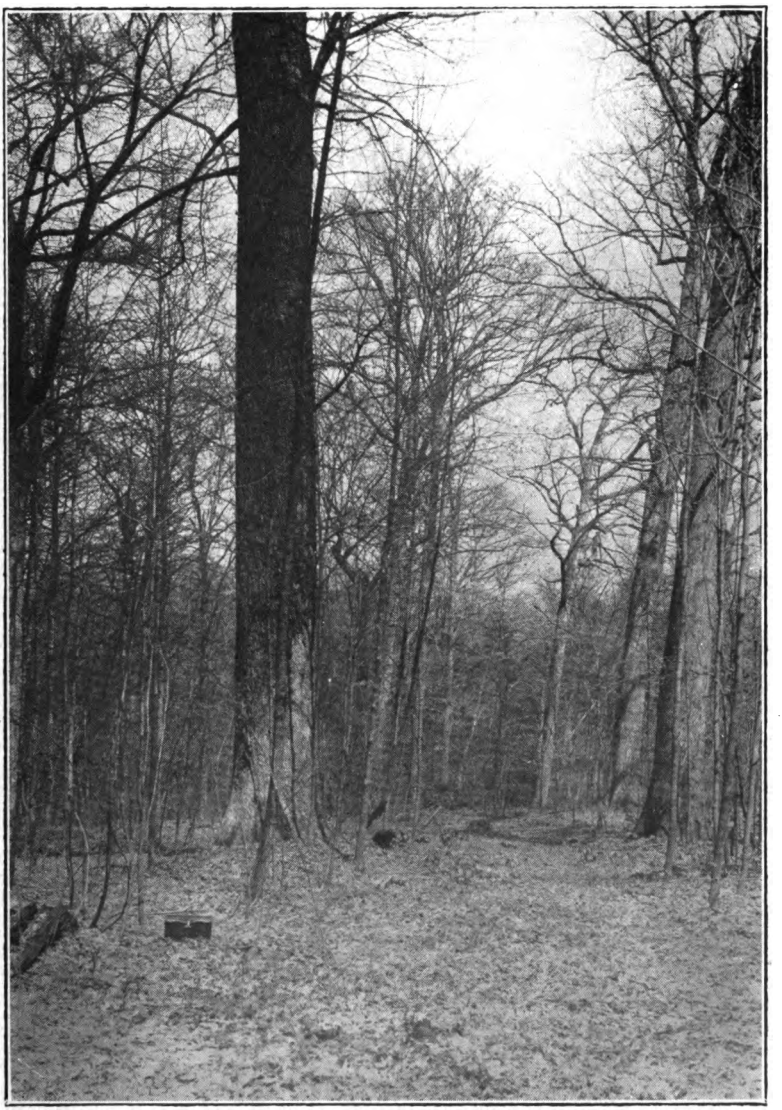


PLATE 4. Some fine white oaks at Turkey Run, Indiana.

PLATE 5. Administration Building, Indiana Forest Reserve.

Reservation.

The Reservation is located one mile north of Henryville, in Clark County. It may be reached by going to Henryville via the Pennsylvania Railroad, or by going via the Indianapolis and Louisville Electric Line. The electric line touches the east side of the Reservation and all local cars will stop at the Reservation station.

The Reservation contains 2,000 acres, purchased by the State in 1903 for the sum of $16,000, as provided by an act of the Legislature, March 3, 1903, for a forest reservation, laboratory of forestry, demonstration and state nurseries.

The Reservation is very irregular in outline, its greatest length is over three miles east and west and its greatest width a little over a mile and a quarter north and south. It lies wholly south of the "glacial drift" and its surface and soil bears but little resemblance to the surface and soil of central and northern Indiana. There is a variety of soil but none of the swampy or sandy variety.

About 600 acres of the northwest part lies in the "knobs," which is more than 300 feet above the eastern portion, and some parts are 1,000 feet above sea level and one of the highest points in southern Indiana. Only about twenty acres of the "knob" area was ever under cultivation. Practically all this part is too badly broken by deep ravines to ever be cleared for cultivation.

Near the western border, which is about a mile long, a deep and for the greater part, narrow ravine extends northwest, draining this area. Several of the secondary ravines are so deep and the slopes so steep as to make travel over this part of the Reservation extremely difficult. However, there is a road leading to the top of the "knobs" from the valley below, which one can drive over up to the "hill house." There is a good road leading from the east entrance of the Reservation past the administration building and through the entire Reservation. Over this road many visitors drive their automobiles and buggies in visiting the place.

The highest portions of the "knobs" are covered with native scrub pine (*Pinus virginiana* Mill.) and chestnut oak (*Quercus Prinus* L.). The lower slopes are covered principally with oak, hickory and beech.

That part of the Reservation east of the "knobs" is rather hilly and is traversed by many irregular ravines. The soil is a compact clay in most parts. The greater part of this area could be cultivated and about three hundred acres were under cultivation when the tract was purchased. While farming is possible, it would not be profitable on the greater part of this area. The woodland is a second growth, composed principally of white, scarlet and black oaks, and hickory.

The greater part of the work on the Reservation has been the reforesting of the old cleared fields which were in most part not profitable for farming. The controlling idea in reforesting these fields is to plant such species as give promise of being the best for use in this State. The various species are planted and managed in many different ways in order to determine which method should be followed in forestry and how the best returns may be obtained. The first planting on the Reservation was done in the fall of 1904 and up to October 1, 1914, seventy-nine tracts have been planted, having a total area of 213.67 acres. Some of the tracts have been planted long enough to give a definite idea of final results. The progress of some of them is given in another part of this report. Additional tracts are planted each year to species whose silviculture for Indiana have not as yet been determined.

In the past year the work of planting white oak and burr oak acorns, and shellbark hickory nuts was done in the fall of 1913.

FIELD PLANTING.

The following tracts were replanted to nuts in the fall of 1913:

TRACT 50.

This is an experiment in planting a wornout field to white oak seed after cleaning with the ax. Soil a compact clay, formerly wooded with white and black oak, good natural drainage. In the work of replanting the nuts were planted by the seed spot method, 4 x 4 feet. Part of the tract was planted to light nuts, four to the hill, and other part with heavy nuts, using three to the hill. The expense of replanting is as follows:

Oct. 27-28.	Labor planting nuts	$7 17
	4 bu. nuts at $1.00 per bu	4 00
		$11 17

TRACT 55.

This is an experiment in planting a cleared field to shellbark hickory by planting the nuts in the fall. The greater part of the tract is low and flat; the east side is the base of a white and black oak ridge. The nuts were planted in the fall of 1911. The stand was reinforced with nuts in the fall of 1913 as follows:

Oct. 30-31.	Labor planting nuts	$7 87
	3½ bu. hickory nuts at $1.25	4 40
		$12 27

TRACT 56.

This is an experiment in planting a cleared field to burr oak. Soil a sandy loam, surface low and flat. West boundary a ravine. The ground was prepared in the fall of 1911 and three nuts planted in each intersection of the rows 4 x 4 feet apart. Replanted in the fall of 1913 as follows:

Nov. 25-29.	Labor planting nuts	$6 13
	5 bu. nuts at $1.25	6 25
		$12 38

TRACT 57.

This tract is an experiment in planting an old wornout field to white oak, without any cleaning or preparation of the ground. The tract was originally wooded with white and black oak but had been cleared and farmed until about ten years ago. In the meantime it had become covered with shrubby growth of various kinds. The seed was dibbled in with spades, three acorns to a hill. Replanted in the fall of 1913 at a cost of $8.92, including the labor of planting.

In the spring of 1914 the following tracts were reinforced with seedlings:

TRACT 45.

This tract is planted to ash and tulip, alternating the species, part of it receiving cultivation and part not receiving cultivation. The soil for the greater part is a light loam. The north part of the tract was reinforced in April with 396 tulip seedlings at a cost of $3.69, which includes the labor of planting the trees.

TRACT 49.

This tract was planted to wild cherry in the spring of 1912. The surface is gently sloping to the southeast. The soil of the

northwest part is a light, compact clay, the remainder more porous. The trees were planted 8 x 8 feet on the hexagonal system and undercropped with corn for two years. In the spring of 1915 it is decided to plant a nurse crop of black locust midway between the trees. The expense on the tract for 1914 is as follows:

April 24.	Preparing the ground	$1 20
	Labor planting trees	70
	363 seedlings at $4.00 per M	1 45
May 22–June 22.	Pruning and two cultivations	85
		$4 20

TRACT 64.

This tract is a part of a cleared field which had been farmed for many years, surface low and flat, soil fairly porous. The purpose of this planting is to find a good species for low ground planting. It was decided to use cuttings in getting a stand since this method of planting would be cheaper than using seedlings. The tract was plowed in the fall and marked off one way. In the spring of 1913, Carolina poplar cuttings were planted by inserting a rounded and pointed stick in the ground at an angle and firming the ground about the cutting by tramping. The cuttings were spaced 3½ x 3½ feet. The ground was dry when the cuttings were planted and it did not rain until May 9, which was unfavorable. The experiment was repeated in the spring of 1914 under more favorable conditions.

The expense on the tract for 1914 is as follows

April 22-24.	Preparing the ground	$6 00
	Labor planting cuttings	3 93
	5,740 Carolina poplar cuttings at $1.00	5 74
		$15 67

TRACT 67.

Tract 67 was planted to catalpa in the spring of 1913, the purpose of which was to determine the relative value of 12, 24 and 36 inch seedlings. The tract was replanted in the spring of 1914 and the expense is as follows:

April 23.	Labor replanting trees	$0 70
	457 catalpa seedlings at $3.00 per M	1 37
	Pruning	87
		$2 94

TRACT 68.

The purpose of this tract is to determine if the Norway spruce can be used to advantage in reforestry work in Indiana. It is a part of a cleared field which had been under cultivation for a number of years, surface level, soil for the greater part a compact clay, good surface drainage. Two year old seedlings were planted in the spring of 1913, 4 x 4 feet apart. Replanted in the spring of 1914 at an expense as follows:

April 22.	Labor replanting trees	$0 52
	930 Norway spruce seedlings at $8.00	7 44
May 6–Aug. 20.	Pruning and three cultivations	12 25
		$20 21

TRACT 69.

In the spring of 1913 this tract was planted to European larch to determine if the species is adapted for reforesting in Indiana. The seedlings were 2-year transplants purchased in Germany and many of them were heated in transit. Practically all of the seedlings died and the tract was abandoned.

In the fall of 1913, the tract was prepared for planting as for corn and planted to white oak nuts. The expense is as follows:

Oct. 21, 1913.	Preparing ground	$3 00
Nov. 3, 1913.	2¼ bushels white oak acorns	2 25
Nov. 3, 1913.	Labor planting nuts	2 10
May 8–Aug. 20, 1914.	Cultivation	10 85
		$18 20

The stand of young white oak is excellent.

TRACT 71.

This tract was planted in the spring of 1913 to scrub pine by the "rock in" method, to determine the best method to reforest with this species. The tract is a part of a field which had lain idle since 1903. In the meantime it had grown up in sassafras, scrub pine, persimmon and briers. Surface rather level, with good drainage, soil a compact clay. Dry weather for an interval of over four weeks after the planting caused many of the seedlings to die. The experiment was repeated in the spring of 1914 with better results. Expense as follows:

April 15-20.	Labor replanting seedlings	$8 23
	4,520 scrub pine seedlings at $2.50	11 30
		$19 53

TRACT 73.

This tract has the same soil conditions as Tract 71, and is for the purpose of determining the best methods of reforesting with scrub pine. It was prepared for planting by plowing in the fall of 1912 and harrowing and marking out both ways just before planting in the spring of 1913. A drought of over a month following the planting caused many to die.

In the spring of 1914 the tract was replanted. Expense as follows:

April 20-23.	Preparing ground	$7 20
	Labor replanting seedlings	5 25
	5,028 scrub pine seedlings at $2.50	12 57
May 21.	Cultivating trees	60
		$25 62

TRACT 74.

This tract is practically surrounded by woods, the original forest of the white-black oak type. Soil clay, surface level, good drainage. The purpose of this tract is to show the behavior of certain species in a mixed planting. The tract was prepared in the fall of 1912 and planted the following spring to chestnut oak, ash, basswood, locust, catalpa, elm, sycamore, and tulip. Reinforced in the spring of 1914 to complete the stand at an expense as follows:

April 21-22.	Labor replanting trees	$2 45
	200 ash seedlings	60
	625 tulip seedlings	5 00
	606 sycamore seedlings	1 82
	20 elm seedlings	06
	300 black locust seedlings	1 00
	25 catalpa seedlings	07½
May 1–July 18.	Pruning and cultivating	15 50
		$26 50½

TRACT 77.

This tract is an experiment in growing white elm in a pure stand in low undrained soil. The ground was prepared as for corn and planted in the spring of 1913, part of the seedlings planted 4 x 4 and part 5 x 5 ft. Reinforced in the spring of 1914 and the expense was as follows:

April 23.	Labor planting trees	$0 70
	440 white elm seedlings at $3.00	1 32
May 19–June 22.	Pruning and cultivating	5 52
		$7 54

A good crop of corn and oats was raised on parts of the Reservation that have not been set to trees.

The forest tracts are pruned during the winter months when no other work except forest cleaning can be done. At spare times work is continued on the driveway that extends from the main entrance of the park to the hill house on the knobs, a distance of almost four miles. Most of this driveway is now graded and graveled and drained. Work on it will be extended as funds permit.

FOREST CLEANING.

During the past year the underbrush on about twenty acres has been cut and burned. This clearing was done on the land that had been burned over on April 23, 1914.

The fire lines have been kept cleared and special care taken to maintain them in the best condition possible to prevent the spread of fire. It is proposed to establish more of these fire lines that fires in the future may be controlled more easily.

INSECT DAMAGE.

The insect damage to the trees on the Reserve the past year has been very slight. The first brood of catalpa sphinx made its appearance the last of May in Tract 33. This tract was carefully sprayed with a solution consisting of two gallons of lime of sulphur and one and a half pounds of arsenate of lead in fifty gallons of water. Its use protected the trees from any further ravages of the pest and the trees made an excellent growth.

FOREST FIRES.

On April 23, 1914, occurred a very destructive fire on the Reserve, burning over more than three hundred acres of the native forest and eight acres of white ash plantings.

The fire was caused by carelessness in burning brush on an adjoining farm and permitting the fire to escape to the Reserve without giving any notice to the custodian or the road supervisor until the fire had gained such headway as to be beyond control of the ordinary force used on the Reserve. The supervisor called out

a large force of men and after a combined fight lasting until late in the evening, the fire was gotten under control, and a guard maintained all night and the next day, that no further damage might occur.

The damage was at least three thousand dollars; many of the trees which looked in early spring like they would recover from the effects of the fire, died during the summer.

The ash planting was so badly injured that it was coppiced the week following the fire and the trees have sent up many new shoots, which will be carefully thinned to the right number, which may in time become fair trees.

A part of the native forest burned over has been given a cleaning by cutting out most of the underbrush and trees killed by the fire, but as yet we are unable to tell how many of the trees will die from the effect of the fire. We certainly need more stringent laws against setting out fires without due notice to adjoining owners of land.

GENERAL IMPROVEMENT.

In the past year we built a cistern on the reserve at the administration building, nine feet in diameter and seventeen feet deep, which will contain about two hundred and twenty-five barrels of water.

Two wells were drilled on the reserve about two miles west of the administration building, one, one hundred and forty-four feet deep in which only a small flow of water was found and that too salty for use; the other ninety-eight feet deep, in which plenty of water was obtained but was too salty for use. A pump is now placed in the well to pump out the water a number of times, to see if the water would not become fit for use.

RAINFALL ON THE RESERVE.

On March 1, 1912, the Board established a weather bureau station. Since that time an accurate account has been kept of the daily precipitation and the maximum and minimum temperature at the Reserve.

Although a drouth extended over a greater part of the State during the early part of the past summer, there was plenty of rain on the Reserve and all of the plantings made a good growth the past season.

A tabulated statement of the rainfall for the months October 1, 1913–September 30, 1914, is as follows:

DAY.	Oct.	Nov	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.
1	0.00	0.00	0.21	0.00	0.00	0.00	0.39	0.00	0.06	0.11	0.00	0.00
2	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.08	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.09	0.25	0.00	0.00	0.17	3.08	0.00	0.00	0.00
6	0.00	0.00	0.23	0.00	0.08	T.	0.00	0.21	0.00	0.00	0.00	0.18
7	0.00	0.31	0.07	0.00	0.14	0.05	0.15	0.23	0.00	0.00	0.15	0.00
8	0.00	0.75	0.00	0.00	0.00	0.02	0.11	0.17	0.00	0.00	0.46	0.42
9	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.11	0.00	T.	0.06	0.00
10	0.00	0.00	0.00	0.00	0.06	T.	0.00	0.00	0.00	T.	T.	0.00
11	0.42	0.00	0.00	0.00	0.00	0.76	0.31	0.00	0.00	0.00	0.87	0.17
12	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.11	0.00	0.00	0.00
13	0.00	0.10	0.00	0.00	1.14	0.00	0.00	0.00	0.00	T.	0.00	0.00
14	0.00	0.63	0.00	0.00	0.10	0.00	0.41	T.	0.37	0.51	0.61	0.00
15	0.00	1.23	0.00	0.00	0.02	0.00	0.68	0.00	0.00	0.00	0.00	0.00
16	0.00	1.24	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.16	0.00	0.00
17	0.48	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	1.89	0.00	0.00
18	0.00	0.00	0.00	0.00	0.80	0.07	0.00	0.00	T.	0.00	0.00	0.00
19	0.08	0.00	0.00	0.00	1.92	0.06	0.13	0.00	0.00	0.00	0.00	0.00
20	0.47	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.12	0.00
21	0.01	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00
22	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.37	0.05	0.53	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.93
24	0.78	0.00	0.00	0.28	0.05	0.00	0.04	0.00	0.16	0.00	0.65	0.00
25	0.09	0.00	0.43	0.00	0.00	0.02	0.46	0.00	0.00	0.00	1.70	0.00
26	0.00	0.12	0.03	0.00	0.00	0.00	0.20	0.00	0.00	0.17	0.00	0.00
27	0.23	0.11	0.00	0.00	0.00	1.98	0.09	0.00	0.00	2.98	0.00	0.00
28	0.00	0.16	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	1.07	0.00
29	0.09	0.13	0.00	0.00	.....	0.29	0.06	0.00	0.00	0.00	0.13	0.00
30	0.00	0.35	0.00	0.14	.....	0.00	0.00	0.00	0.00	0.00	0.00	0.00
31	0.00	.....	0.00	1.03	.....	0.01	.....	0.00	.....	0.00	T.	.....
Sum	3.10	5.20	1.86	1.86	5.45	3.28	3.06	1.05	3.78	5.82	6.14	1.70
SNOWFALL.												
5	.....	.....	.....	1.60	3.40	.....	.....	.....	.....	.....	.....	.....
11	.....	.....	.....	.....	.....	5.40	.....	.....	.....	.....	.....	.....
13	.....	.....	.....	.....	6.40	.....	.....	.....	.....	.....	.....	.....
14	.....	.....	.....	.....	1.50	.....	.....	.....	.....	.....	.....	.....
15	.....	.....	.....	.....	0.60	.....	.....	.....	.....	.....	.....	.....
23	.....	.....	.....	.....	1.40	.....	.....	.....	.....	.....	.....	.....
25	.....	.....	1.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sum	.....	.....	1.50	1.60	13.30	5.40	.....	.....	.....	.....	.....	.....

Total amount of precipitation for the year.....44.46 inches.

PLATE 6. Tract No. 1B, White Ash.

RECEIPTS FROM SALES.

The receipts from sales for the past fiscal year are as follows:

Nov. 22, 1913—Samuel Dean, 14 shocks of corn at 25 cents.....	$3 50
Jan. 5, 1914—Chas. Guernsey, 75 shocks fodder at 10 cents.....	7 50
Jan. 29, 1914—John W. Allen, 1 span mules and harness.....	207 50
Total	$218 50

PROGRESS OF TRACTS.

A statement is here given of a number of tracts on the Reservation to show what progress in growth may be expected of a planting in ordinary soil in the time given in each case. The measurements given were taken on November 18, 1914 and average trees were selected for measurements. The diameter was taken at 4½ feet from the ground.

Tract 1A.—Area .65 Acres: White Ash. Seed planted in fall of 1904. Thorough cultivation for two years, moderate cultivation for the next four years. Given a severe pruning in the spring of 1910. No pruning since that date. Average height 15 feet. Average diameter 2 inches.

Tract 1B.—Area 1.24 Acres: White Ash. Seed planted in the fall of 1904. This tract was given the same cultivation as Tract 1A. Most of the trees were moderately pruned. Height 15 feet. Diameter 2 inches.

Tract 2.—Area 2.38 Acres: This tract was a cleared field, which was planted in the fall of 1904 with chestnut and black oak acorns. In the spring of 1908 the vacant places were planted with tulip seedlings. The tract was cultivated for six years. In the spring of 1910 and 1911 it was given a moderate pruning. Height 12 feet. Diameter 1½ inches.

Tract 3.—Area 2.98 Acres: Tulip or yellow poplar. Seedlings were planted in the spring of 1907. Cultivated for four years. Given a severe pruning in the spring of 1910 and a moderate pruning in 1911. About 10 per cent of the trees were winter-killed in 1911-12. The trees that were injured were cut and the whole given a select thinning. Height 17½ feet. Diameter 2½ inches. (Plate 7.)

Tract 4.—Area 1.96 Acres: Black Walnut. Seed planted in fall of 1905. The vacant places were planted in the spring of 1907 with white ash and tulip seedlings. The tract was cultivated more or less for five years. In the spring of 1910 all of the trees were

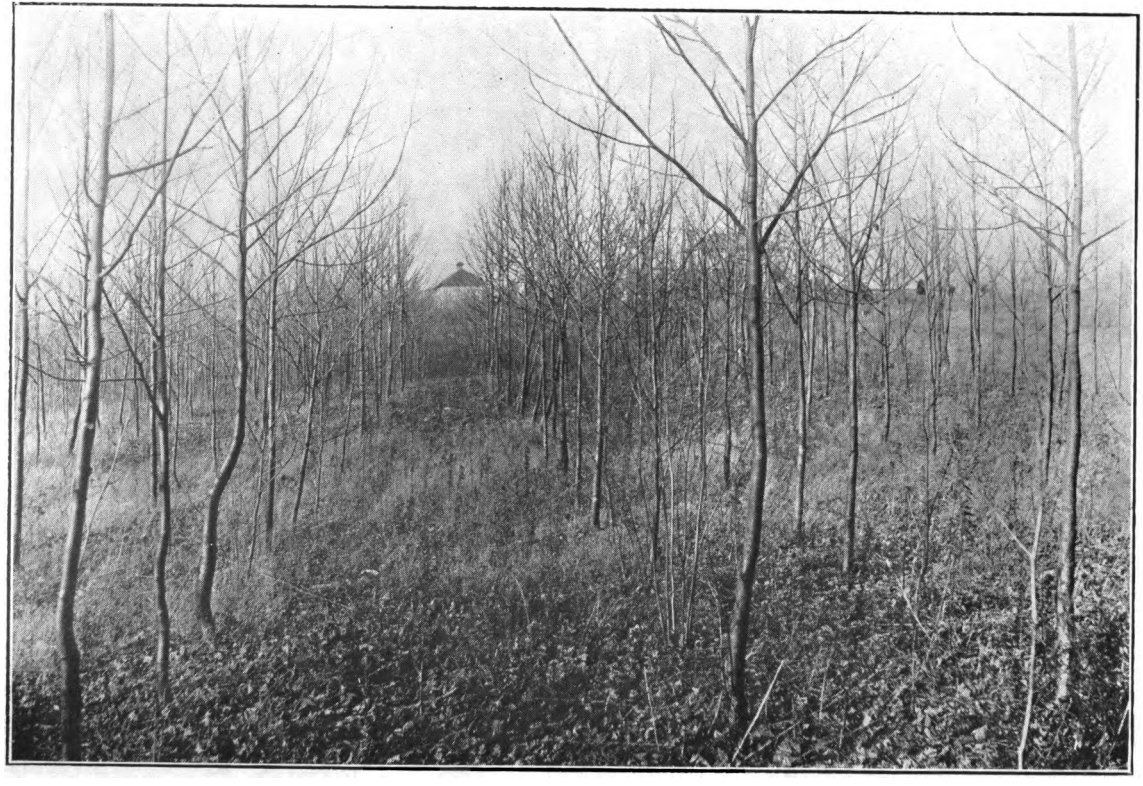


PLATE 7. Tract No. 3, Yellow Poplar.

pruned except ten rows on the west side which are not to be pruned. The trees that showed a straight growth were pruned to a switch the bushy ones were coppiced. Many of the trees were severely injured by being winter-killed in 1911-1912. This necessitated a general thinning which was done. Height 12 feet. Diameter 1¾ inches.

Tract 16.—Area 5.64 Acres: Black Walnut. Seed planted in the spring of 1904. Cultivated for seven years. Pruned in the spring of 1910. The straight trees were given a moderate pruning and all the crooked ones were coppiced. Of 1,248 coppiced 1,217 of them sent up sprouts and about 60 per cent. of these sprouts were straight, thus showing that a planting of black walnut can be improved by coppicing at the proper time. Height 10 feet. Diameter 1½ inches.

Tract 20.—Area .18 Acre: This is another experiment of reforesting an old field by planting acorns of the chestnut and black oak in the fall of 1906. No cultivation was given. Height 7 feet. Diameter 1 inch.

Tract 21.—Area 2.71 Acres: This tract was a cleared field which was planted with acorns of several species of oak. The seed of two species planted on the east side grew but the rest did not and has been planted to catalpa. Height 10 feet. Diameter 1½ inches.

Tract 22.—Area .27 Acres: This tract was planted to black locust by using seedlings in the spring of 1907. Cultivated for several seasons. Pruned in spring of 1910 and 1911. Height 15 feet. Diameter 2¾ inches.

Tract 23.—Area .31 Acres: This tract was planted with seedlings left from planting other tracts. Very little cultivation has been given this tract. Height 10 feet. Diameter 2 inches.

Tract 24.—Area 2.89 Acres: Black Walnut. Seeds were planted in the fall of 1907. Cultivated three years. In the spring of 1910 the trees were pruned to a switch and in the fall were given a moderate pruning. In the fall of 1911 the tract was divided east and west into two equal parts. The north half was not pruned, and all the straight trees on the south half were given a moderate pruning, while all the crooked ones were coppiced. Height 6 feet. Diameter 1 1-7 inches.

Tract 25.—Area 8.83 Acres: This tract was a cleared field which was planted in the spring of 1910 with tulip and black locust. This tract is designed to show the most profitable way to grow tulip. The tract is divided into four equal parts. Part 1, north

west, planted 8 x 8 feet alternately with tulip and locust. Part 2, northeast, planted 8 x 8 feet with tulip. Part 3, southwest, was planted 4 x 4 feet alternately with tulip and locust. Part 4, southeast, was planted 4 x 4 with tulip. All the parts were cultivated for two years. Height of tulips 8 feet. Diameter 1½ inches.

Tract 26.—Area 1.71 Acres: Tulip. This tract was planted in the spring of 1907 and cultivated for four years. In the spring of 1910 all the trees were given a moderate pruning except 10 rows of trees on the west side, which were not pruned. In 1911-12 about 400 trees were winter-killed, and it was thought best to coppice them to see if the new sprouts would make healthy trees. Height 17 feet. Diameter 2½ inches.

Tract 27.—Area .62 Acres: This tract was planted with seedlings of black locust in the spring of 1907, cultivated each season for four years. Pruned to a switch in 1910 and given a moderate pruning each season since. Height 14 feet. Diameter 2 inches.

Tract 28.—Area 9.92 Acres: This tract was planted with sprounted black walnut and shellbark hickory nuts in the spring of 1910. This plat was undercropped for three years. Height 6 feet. Diameter 1 inch.

Tract 29.—Area .10 Acres: This tract was planted in the fall of 1904 with seeds of the chestnut. Cultivated for seven years. Given a moderate pruning in the spring of 1911 and 1913. Height 10 feet. Diameter 1½ inches.

Tract 30.—Area .10 Acres: This tract was planted in the fall of 1904, with nuts of the pecan and cultivated for seven years. Pruned to a switch in the spring of 1911. Height 7 feet. Diameter 1 inch.

Tract 31.—Area .60 Acres: This tract was planted in the fall of 1906 with seed of the coffeenut. The vacancies were planted in the spring of 1908 with tulip. Cultivated for five years. Moderately pruned in 1910, 1911 and 1913. Height 4 feet. Diameter ½ inch.

Tract 32.—Area .52 Acres: This tract was planted in the fall of 1904 with seeds of the black locust. The part south of the road has been given a moderate pruning in the spring of 1910. Height 18 feet. Diameter 3 inches.

Tract 33.—Area 6.40 Acres: This tract was planted in the spring of 1910, 8 x 8 feet. The catalpa sphinx has at times defoliated parts of this planting, but by careful spraying the past year all ravages have been stopped. Many of these trees have been

coppiced in the past in order to obtain straight trees. Height 9 feet. Diameter 2 inches.

Tract 34.—Area 3.79 Acres: This tract was planted with white ash seedlings in the spring of 1909, cultivated three years, undercropped with corn one year, 1910. Height 8 feet. Diameter 1½ inches.

Tract 35.—Area 5.16 Acres: This tract was planted with white ash in the spring of 1909, cultivated three years but not undercropped. This planting was burned over by a forest fire on April 23, 1914, and all of the trees except a few were coppiced April 30th. Many sprouts have been sent up by the coppiced trees. These sprouts will be thinned to one in each place this winter and allowed to grow.

Tract 36.—Area 4.11 Acres: Planted with white ash seedlings in the spring of 1908, cultivated for three years. Given moderate pruning in 1911. Height 14 feet. Diameter 1¾ inches. (Plate 8.)

Tract 37.—Area 6.22 Acres: This tract was planted with ash and elm seedlings in alternate rows. The ground was not broken as in tracts 35 and 36 but were planted with a spud, cultivated for four years. Height 10 feet. Diameter 1¾ inches.

Tract 38.—Area 2.14 Acres: Planted to white ash in 1908 in the same way as Tract 37. Height 10 feet. Diameter 1¾ inches.

Tract 39.—Area 4.18 Acres: This tract was planted with seed of black walnut, oak, hickory and chestnut in the fall of 1904. Many of the seeds failed to grow and the missing places were planted with seedlings of ash and elm in the spring of 1908. Cultivated for four years. Moderate pruning in the spring of 1911. Height 9 feet. Diameter 1½ inches.

Tract 40.—Area 2.53 Acres: This tract was planted with seedlings of Catalpa in the spring of 1908 and cultivated for three years. Part has been coppiced and the remainder moderately pruned. Height 12 feet. Diameter 2¼ inches.

Tract 41. — Area 5.04 Acres: This tract was planted in the spring of 1908 with seedlings of catalpa, black locust and yellow poplar. Cultivated for four years. Has received moderate pruning. Height 18 feet. Diameter 3 inches.

Tract 42. — Area 1.02 Acres: This tract was planted in the spring of 1911 with ash, elm and sycamore seedlings. Cultivated for three years, first and second year undercropped with corn. The tract is laid off east and west in three blocks of 21 rows each. The first seven rows on the north have received a severe pruning,

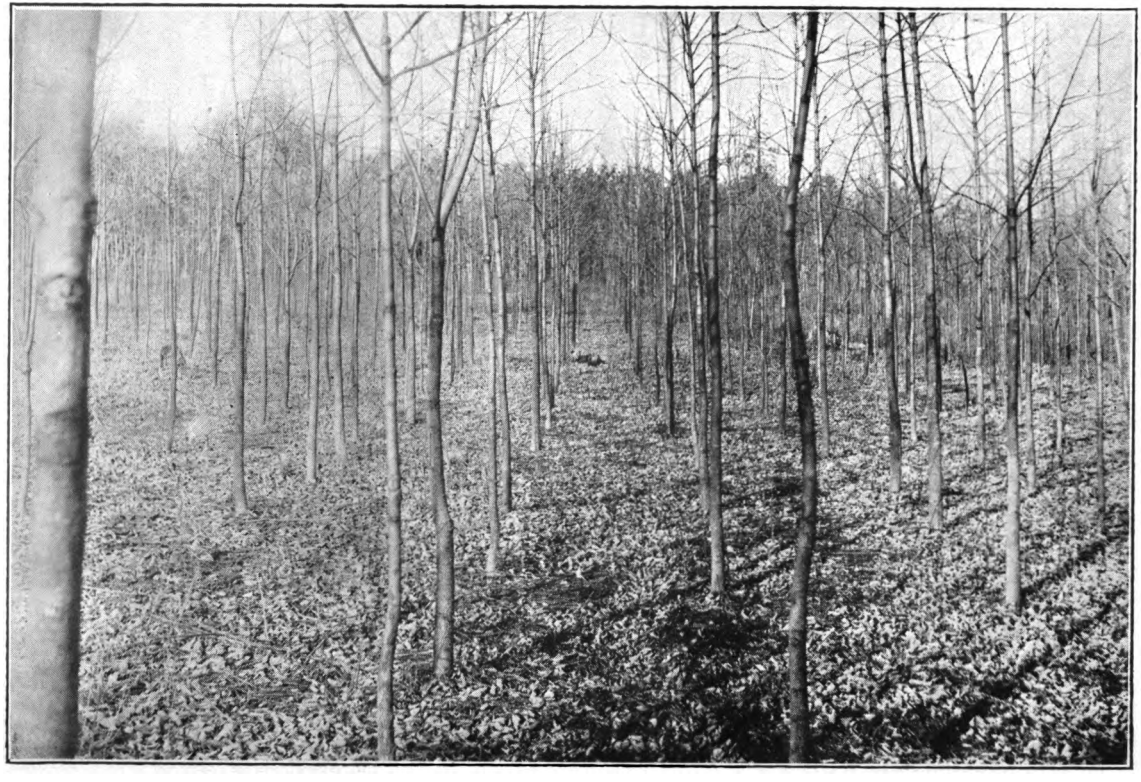


PLATE 8. Tract No. 36, White Ash.

the next seven rows in each block only a moderate pruning, the next seven or the south seven in each block have not been pruned since planting. Height 8 feet. Diameter 1½ inches.

Tract 44.—Area 3.90 Acres: This tract was planted in the fall of 1906 with black walnut and chestnut. The chestnut failed to grow and that part was planted to black locust in the spring of 1911. Cultivated for five years. Height 9 feet. Diameter 1½ inches.

Tract 45.—Area 5.8 Acres: Planted to ash and yellow poplar seedlings in the spring of 1912. Given only slight cultivation. Height 3½ feet. Diameter ¾ inches.

Tract 46.—Area 10.1 Acres: This tract was planted with black locust seedlings in the spring of 1912. The north half has received no cultivation, the southeast quarter was cultivated for one year and the southwest quarter was cultivated for two years. Height 8 feet. Diameter 1½ inches.

Tract 47.—Area 2.66 Acres: This tract was planted in the spring of 1912 with seedlings of linn or basswood. The tract was undercropped with corn in 1912. Next year black locust will be planted between them. Height 3 feet. Diameter ½ inch.

Tract 49.—Area 1.02 Acres: This tract was planted in 1912 with seedlings of the wild cherry, 8 x 8 feet apart. Undercropped with corn in 1912. Next year black locust will be planted between the rows. Height 5 feet. Diameter 1 inch.

Tract 50.—Area 3.14 Acres: This tract was an old field planted by the seed spot method to white oak acorns in the fall of 1911. These failed to grow and the field was plowed and well prepared and planted again in the fall of 1913. Height 5 inches.

Tract 51.—Area .97 Acres: This tract was planted in the spring of 1911 with seedlings of cottonwood, 4 x 4 feet. Cultivated two years. Height 4 feet. Diameter ½ inch.

Tract 61.—Area 3.73 Acres: This tract was planted with sycamore seedlings in the spring of 1913, north half 4 x 4 feet, south half 5 x 5 feet. The north half only was cultivated. Height 3 feet. Diameter ½ inch.

Tract 63.—Area 3.6 Acres: This tract is part of an old cleared field, which was planted with red oak acorns in the fall of 1912. Three to four seeds were planted in a hill. Two-thirds of the tract was planted 4 x 4 feet and the rest 5 x 5 feet. Height 6 inches.

Tract 66.—Area 1.7 Acres: This tract was plowed and prepared in the fall of 1912 and planted in the spring of 1913 with

sycamore and cottonwood seedlings in alternate rows. Height 3 feet. Diameter ½ inch.

Tract 67.—Area 1 Acre: This tract was planted with catalpa seedlings in the spring of 1913. Height 3 feet. Diameter ½ inch.

Tract 68.—Area 2 Acres: This tract was planted May 3, 1913 to Norway spruce, 4 x 4 feet. Cultivated for two years. Height 10 inches.

Tract 69.—Area 1.75 Acres: This tract was planted November, 1913 with white oak acorns, 4 x 4 feet. A good stand was obtained. Cultivated in 1914. Height 4 inches.

Tract 74.—Area 4.3 Acres: This tract is a mixed planting 5 x 5 feet to test the relative endurance of the species used. Cultivated in 1913 and 1914. Height 5 feet. Diameter 1 inch.

Tract 75.—Area 1.46 Acres: This tract is an experiment of reinforcing an open woodland with a pure stand of black locust. The trees were planted April, 1913 by the slit method. The number of trees used was 3,492. Height 2½ feet. Diameter ½ inch.

Tract 76.—Area 1.46 Acres: This is an experiment of reinforcing an open woodlot with a pure stand of catalpa. The seedlings were planted in May 1913, by the slit method. The number of trees used was 2,580. Height 2½ feet. Diameter ½ inch.

Tract 77.—Area 2 Acres: This is an experiment in growing white elm in a pure stand in low ground. The tract was thoroughly prepared and planted with seedlings in May, 1913. The west half was planted 4 x 4 feet, and the east half 5 x 5 feet. Cultivated in 1913 and 1914. Height 2½ feet.

Prize Essay for 1914.

The object of the State Board of Forestry in offering a prize for an essay in forestry is for the purpose of stimulating a study of certain phases of the subject. In order to accomplish this it is necessary to impose some conditions upon the contestants. The subject of the essay was "Forest Influences." The following are the conditions governing the contest:

Pupils are requested to write on the subject in the following order:

1. Relation to Rainfall.
2. Relation to Temperature.
3. Relation to Animal Life.
4. Relation to Industries.
5. Relation to Sanitation.

The manuscript must be written in ink on good white paper, and the essay must not exceed 2,000 words. It must be mailed to E. A. Gladden, secretary of the State Board of Forestry, Indianapolis, Ind., not later than May 1, 1914.

The essays were graded on the basis of 75 per cent. for thought and 25 per cent. for composition.

Those who were awarded prizes are: High School—Ruth Jacobs, Goshen, first prize; Kenneth Grimes, Kokomo, second prize. Graded and Country Schools—Muriel Kinney, Elkhart, first prize; Mary White, Bloomington, second prize.

Glenn Bond, of Nashville, submitted the best essay, but as his essay exceeded 2,000 words he was not given a monetary prize but awarded the honorary prize and his photo and essay are given in this report.

Eighty-seven pupils of the high schools and sixty pupils of the graded and country schools participated in this contest. Many of the essays submitted to the board were selected as the best from a number written by pupils in various schools. The essays were in general of a high order and the task of grading them was performed by the secretary, E. A. Gladden, and Dr. Stanley Coulter.

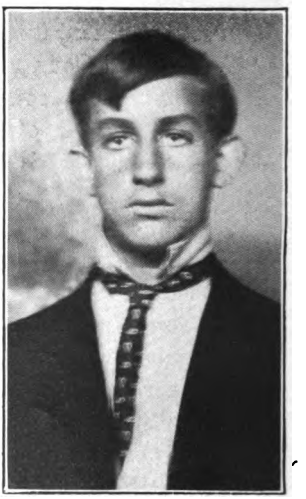
The board believes that another contest should be given for the year 1915, as there is no doubt of the growing interest taken in forestry by the people of the State.

Glenn Bond.

Muriel Kinney.

Ruth Jacobs.

Mary White.



Kenneth Grimes.

PLATE No. 9. Successful Prize Essay Contestants.

FOREST INFLUENCES.

The study of forestry is at the present time only in its youth and in this country has been taken up only within the last twenty-five years. In spite of this fact most satisfactory results are accruing.

It is seldom that two men definitely agree as to the influences of the forests and which influence is of the most weight in economic conditions. It is rather difficult for one who is not acquainted with this subject to know what material to use, because all that has been said upon forest influences seems reasonable.

First let us consider Relation to Rainfall. We may take two equal areas one forested, the other deforested. The area which is deforested, is dry and arid, and when rain falls the water runs off immediately, because the earth is hard. When rain falls on the forested area, the water is taken into the earth and then it gradually evaporates. Because of the absorption of the water and the slow evaporation, in forested lands, the earth may be compared in these respects with a sponge or blotter. This water which the soil and rocks hold supplies springs and wells and also streams, except at flood times. Therefore the forests really hold the key of the great reservoirs of water.

The leaves and litter which cover the ground keep the earth moist and allow the water to sink in so as to feed the springs, wells and rivers. "It is the amount of rain that passes into the ground and not the amount that falls, which is of value," aptly says a man of the United States Weather Bureau.

When the soil is robbed of its vegetation it becomes like the roof of a house, that is, hard and flat. This causes the water to run off rapidly. Experiments in Burnt Creek, New Hampshire, and in Europe, made by the United States Geological Survey, have proven that water runs off twice as fast on a deforested slope as on a slope which is forested.

It has been found that erosion is seldom beneficial. The harmful effect of erosion is clearly shown in the South. The water comes down the mountain sides in torrents, bringing sediment which covers the farming lands. As a result, these lands cannot be used. In Carolina, gullies fifty feet deep and three feet wide at the top have cut through the fields, thus causing fields of forty or fifty acres to be abandoned. This is due somewhat to deforestation.

In Switzerland and France thousands of acres have been re-

claimed through reforestation of the slopes. Last spring, in the States of Indiana and Ohio many cities were greatly damaged by floods. In these States it took thousands of dollars to replace the great losses.

Rain-bearing winds, which go from the oceans inland are more apt to continue rain-bearing if they pass over forests. Therefore it may be said that forests form a secondary source of rainfall.

In Europe an investigation was made in connection with rainfall where there were forests and where there were none. In the forested regions a difference of six per cent. was found. Three per cent. was attributed to the more advantageous position of the rain gauge near the forest, two per cent. attributed to error, and conservative estimates allowed one per cent. actual difference.

When we come to the Relation of Forests upon Temperature, the extent of the influence cannot be ascertained. Forests have somewhat the same effect upon temperature as the oceans, in that they moderate the extremes of heat and cold.

The leaves of the trees are constantly breathing out moisture, thus making the atmosphere around the forests cooler by evaporation. They also act as a covering to the ground by keeping the sun from reaching it.

Experiments have shown that the air in forests in winter is two degrees warmer than the outside air, and in the summer five and four-tenths degrees cooler than that outside. In fact, the soil has been found to be warmer in winter and cooler in summer to a depth of four feet.

The relative humidity is higher around and in forests because (1) leaves are always giving out moisture through transpiration, and (2) because of the low temperature, about the forests, which is due to evaporation.

Fogs often result from transpiration, that is, the leaves are constantly breathing moisture. These fogs act as clouds, thus moderating the heat of the sun's rays. In addition, it may be said that forests have a calm on the leeward side extending out fifteen hundred feet.

The influence of forests on animal life is interesting. About a generation ago the hillsides of the Atlantic States were well forested and abounded in springs and brooks. Now, most of the forests have disappeared and the springs and brooks have decreased in number. The pasture lands of this secton of the country have suffered severely from drought because the forests have been

cleared away. In dry seasons the pastures provide the cattle with neither grass nor water.

The forests act as a shelter for animal life in general, and for the birds especially. Insectivorous birds, which are invaluable to the farmers, must have forests for their home. Therefore, if the forests are all destroyed the injurious insects will kill all the crops because there will be no birds to destroy them.

When the trees are removed the small bushes and plants, which require shade and moisture, will perish, and also the birds which depend upon this sort of vegetation will disappear.

If the forests are destroyed, the birds and animals, such as squirrels, martins, blue jays, raccoons, creepers, woodpeckers, nuthatches, vireos, and opossums, which make their homes in trees, will disappear.

In the underbrush animals and birds, such as rabbits, weasels, chipmunks, ground squirrels, mice, grouse, sparrows, thrushes, wrens and prairie chickens are found. When the forests disappear these species will also disappear, because their home, the underbrush, cannot thrive unless there are forests.

More forests mean more birds and less crop destroying insects. Birds are indispensable for forest preservation, because the insects would kill the young trees if the birds were gone.

Among the five, the influence of forests upon industries can actually be estimated in dollars and cents. Transportation depends largely upon a constant flow and steady volume of water. In general, deforestation has magnified floods in Ohio and Indiana, and because of this transportation has been interrupted to a great extent during flood times.

In the West, streams are more intermittent than they would otherwise be, because of deforestation. Silt is brought down by the streams, filling and clogging them up. This makes navigation difficult and expensive. Annually, floods cost our country $100,000,000 and authorities attribute them in part to deforestation.

In case conservation were not being practiced at the present time, it is estimated that in twenty-five years the lumber supply would be practically exhausted. In the Southern States there are only about fifteen years' supply of lumber left. For example, the Ohio Valley and Lake States were once substantially lumber producing, but now they are mostly agricultural.

The variety of uses and demands for hardwood have increased remarkably in spite of the substitutes such as concrete and steel.

A failure of hardwood would be worse than a crop failure, because the latter is only for one or two years, while a failure of the supply of hardwood would be permanent.

In New England $1,409,000,000 capital is dependent upon a continuous and uninterrupted flow of water. Forests assist in maintaining a continuous water supply and for that reason they are invaluable.

Since the forests preserve the water supply, agriculture upon irrigated lands is dependent to a certain extent upon forests. In the West there are six hundred million acres of irrigable land, which depends upon forests for agricultural uses.

The price of lumber is steadily going up, (1) because the supply is rapidly becoming exhausted; (2) because of the great demand for lumber, and (3) because of the high cross-country rates. For example, the hardwoods from the West and South are more expensive because of transcontinental freight rates. The timber of the North and East is rapidly approaching exhaustion, especially the spruce. This tree has no substitute for paper pulp. In fact, we can go so far as to say, reforestation means a steady supply and lower cost of lumber.

To show the effect of a deforested region, we may take two contrasted countries, one forested, the other deforested. First, let us take the deforested country of Denmark. This is one of the most poorly wooded countries in all Europe. The per cent. of the whole forested area is but four and twenty-five hundredths per cent. This proportion is caused by the barrenness of the western part of Jutland. The forests have been cut down to make way for agricultural lands, for fuel and timber. It has now become a vast desert. The chief indigenous trees are spruce, Scotch fir, aspen and birch. In the fifteenth, sixteenth and seventeenth centuries, laws were made to prevent the destruction of forests, but they did not go into effect until 1805.

The other area, a well forested region, is Canada. About one-third of this country, or eight hundred million acres, is classed as woodland, though the area stocked with commercial timber probably does not exceed two hundred sixty million acres. The net export of wood is two million tons per year. This is more than twice that of the United States. Since 1901 a protective service of fire rangers has been organized in some of the Dominion lands, with excellent results. An interesting fact which indicates the interest taken in forestry, is that citizens have been supplied with

seven million seedlings for forest plantation. It shows that the prosperity and industrial development of the various countries depends upon the treatment of natural resources.

In discussing the last topic we get close to home and can actually cite recent instances. Here the people as a whole are affected. The flood in Ohio and Indiana last year made conditions of living unhealthy. The floods in general resulted in much sickness and loss of life because sanitation was at an ebb. It is said that forests reduce the impurities in the air and for this reason the air in the forests has fewer micro-organisms than that in the open country.

Health resorts which are in or near forests are well planned and logical, because forests cause a reduced wind movement and serve as a protection against extremes of heat and cold.

The regions which are forested have clear streams which are often used for drinking purposes. In dry, arid regions the streams are very muddy. For example, the Gila River in the West is black with mud because the surrounding region is dry and arid.

Riparian towns and villages are in precarious positions because the intermittent stagnancy is favorable to the growth of organisms.

People are beginning to realize more and more the intimate relation between forests and the well-being of a country.

If forestry were taken up in the schools more than it is at the present, I am sure our forests and trees which are used for beautifying towns, villages and cities, would receive more care and attention. There are few people who realize the real value of the forests and for this reason the trees are not treated as they should be.

In the foregoing paragraphs it is shown that there are at least five important influences which every man, woman, girl and boy should know. I think the relation to sanitation is one of the most important of the five topics, because under the other topics only certain classes of people are directly affected while under sanitation the people as a whole are affected.

RUTH JACOBS,
Goshen, Indiana.

Senior.

FOREST INFLUENCES.

When heavy showers occur in regions without forests the streams become very muddy and swift in a few moments. This is due to the fact that when the rain comes down it does not have anything to check its force. It tears up the soil, causing the water to be muddy and washes away the soil. In washing away the soil the water washes deep little gullies. As the years pass by these gullies get bigger and bigger until all the soil is washed away and nothing is left but pebbles and boulders. So quickly does the water run off that very little of it gets into the ground to furnish the under-ground run-off that a good many of our plants depend upon in dry weather. From the under-ground run-off we also get our drinking water; and in may places where there are no forests the wells give out in dry weather.

Grass will not replace the forest in this respect. This is clearly shown by the fact that the Missouri River, after every rain, is a muddy torrent, although it runs through prairies. But, no matter how heavy the rain in the dense forest, the streams always run clear.

As the rain comes down in the forest, it is checked in its fall by the leaves and branches of the trees. And instead of hitting the solid ground when it reaches the ground (or rather earth) it falls upon the leaves, that are on the ground. Then part of it flows away slowly and part seeps into the earth, thus, forming a surface and an underground run-off. And the rain cannot wash any of the soil away by running off so slowly.

Years ago, in a certain country, there was a ridge so steep that the only way anyone could climb it was by taking hold of the beautiful trees and bushes that grew on it. This slope was covered with many beautiful springs from which water was constantly trickling down the hillsides. The surface of this slope was nothing but a thin layer of soil deposited upon a slaty rock. But the growth of trees upon this hillside was large and beautiful. The soil was so rich in the meadow enclosed by this ridge and annually fertilized by the debris washed from the hills, that the owner every year filled his barns with hay, without any cultivation.

A few years later a man purchased this land and began to fell the trees that grew on the hillside. In a few years the land that had grown hay without any cultivation was a rocky waste. The thin soil that had sustained the trees that grew on the hillside, no longer protected by the trees and bushes, was washed away. The

meadow below, by not being annually fertilized by the hills above, in a few years also became a waste. And the water that had once trickled joyfully down the hillsides from the springs did not run any more.

About the end of the eighteenth century part of the French Alps forests were cleared. After they were cleared big floods followed with such regularity and force that many villages were destroyed. Others were abandoned because the floods left the fields often yards deep with sterile gravel and boulders. Then France began the great task of reforesting these mountains.

Thus, the forest in relation to rainfall regulates the flow of water and protects the soil.

In a certain county in Massachusetts there was a little valley near the sea comprising about fifty acres of well cultivated land which was surrounded by hills covered with a dense forest of pine and fir. The seed time and harvest of the land in this valley were always several days earlier than on the land in the open country. The tulips and crocuses in the garden on the south side of the surrounding woods came out so early as to astonish the neighbors of the surrounding country. But in regard to the temperature it varied according to the time of day or night. The woods were cooler in clear, calm weather than in the open country and at the time of dew fall it was greater in the woods and continued so during the earlier part of the night. If the sky was cloudy not much difference could be seen in the temperature of the two situations. In cold and windy weather the woods afforded a comfortable shelter, and although apparently warmer, the thermometer gave no indication of difference.

On a hot summer's day we like to be in the woods because it feels cooler there. This is because of the moisture of the air in the forest. The moisture comes from the damp leaves that are upon the ground. But, instead of carrying coolness it really carries heat. This is easily explained. The sensation of coolness is caused by the increased power of the air to carry the heat from our bodies.

The coolness of the atmosphere over grassy meadows after the sun has set is a common observation. In the forest after the sun has set the air is warm. These differences are not observed on a cloudy night or when a brisk wind is blowing.

On high ground the air is warm in a valley it is cool. When it is calm the greatest amount of moisture is contained by the lowest

stratum of air. But its capacity for retaining heat is proportionally diminished. Consequently the heat from the ground is radiated with great rapidity while the higher strata remain unchanged in their temperature. It has been found that at noonday in calm weather the heat is very near the surface of the ground. But after dew fall the highest temperature is several feet above the surface of the ground, increasing in altitude for some hours after sunset.

The wood checks this radiation in the early part of the night. Like clouds in the evening the trees form a canopy of foliage over the ground and thereby retain the heat many hours after it has escaped by radiation in the open plains.

Palestine, two thousand years ago, was a well-wooded country and all the fruits of the subtropical climates grew there to perfection. The date palm, the fig tree, and the olive tree grew there and bore fruit abundantly.

Palestine is now a treeless country and the same fruits are incapable of enduring its climate. Yet, recent observation has shown that it has the same temperature as it always had. Let the forests be replaced to the hills of Palestine and it will be the same as it was two thousand years ago.

The locust which ravages the East in great numbers is bred in vast open plains which admit the full heat of the sun, to hasten the hatching of the eggs, gather no moisture to destroy them, and harbor no bird to feed on their larvæ. Only since the felling of the forests of Asia Minor and Cyrene has the locust become so fearfully destructive. And the grasshopper, which now threatens to become almost as great a pest to the agriculture of North America, breeds in great numbers only where a wide extent of surface is without woods.

If the whole earth were a forest there would not be many animals. They are not numerous in the forest because it would yield them only a scanty subsistence. This is especially true of birds and insects. The squirrel and its kind could live on the nuts in the forest. The forest border is their nursery and shelter, but their best feeding places are the cultivated grounds. Although their means of subsistence is increased by the clearing of the land and the cultivation of the soil, they require a certain proportion of wild wood for their habitat. The more trees, the fewer animals. The fewer trees, the more animals. Thus, it can be seen that it is best to have a good proportion of each.

Let an orchard be surrounded by woods and the trees will not be molested by big swarms of insects. But if the orchard be out in the open plain the trees will be covered with insects.

Many of our animals live around water. As has been said before, where there are no forests the streams run dry in dry weather. So that the animals that live around water, such as the beaver, lose their homes in dry weather and when floods occur. This is especially true of young fish. In dry weather they are left dying in the mud. And when the floods come they are washed out of their pools into big pools where the large fish destroy them.

Thus with a certain proportion of forest, we may expect to have better crops and not so many insects to destroy the crops.

Wood is used more than any other thing. It is used to make the majority of our tools and implements. If there was no wood the people of the world would feel the loss keenly. And if we never had wood we would have to use metal or stone. This would be very unhandy, because metal and stone are heavier than wood. Then, to have all our things made out of metal or stone would soon be unendurable. Think of all of our houses being made out of stone or metal. We would not like it very well. A plain surface of metal or stone is monotonous while the surface of wood is beautiful to look upon. That this beauty is quite fully appreciated is best illustrated by the fact that pianos, sideboards, and other elegant furniture are not covered with sheet metal as they might easily and effectively be, and that the handsome floors of costly structures are neither painted nor carpeted.

If there were no forests many men would have to find other means of making a living than they are making it now. Along the Columbia River there are many men who make their living by fishing. If there were no forests many of our fur bearing animals would soon be destroyed because they would have no home to shelter and protect them.

Some of our best medicines come from the roots of trees and bushes and if there were no forests we could not get them.

After the floods, in districts where there are no forests, all kinds of rubbish is left along the banks. Then, all kinds of disease carrying insects swarm around the rubbish and then go away to spread disease. This is best illustrated by the fact that most of our sickness is in the spring and early summer when the floods come.

The forest protects us from disease. In Georgia, when the

fevers come, many of the people flee into the pine woods to escape them.

In the cities, where the streams that run through them are dirty and full of rubbish, there is nearly always some sickness among the people along the banks. If the cities are close together, and the stream runs through an open plain, the stream will get dirtier and dirtier. This is because of the swiftness of the water. But if the stream runs through a forest it will be clean by the time it goes from one city to another. This is because the water goes slowly through the forest and this gives the stream a chance to drop its rubbish.

KENNETH GRIMES,
Kokomo, Ind.

Freshman.

FOREST INFLUENCES.

"He that plants a tree, plants joy."

Forests are very valuable for their timber, roots of certain plants, herbs, leaves and by-products, but their effect on rainfall, temperature, animal life, industries and sanitation is far more valuable.

The winter and spring precipitation is not affected very much by the presence or absence of the forests, but the summer and autumn rains are greatly modified. We do not possess complete scientific proof that forests increase rain, but known laws governing rain and physical effects of forests lead straight to the conclusion. A part of the falling snow or rain is checked by the tree tops and returned to the air by evaporation. But this evaporation is wholly or mainly compensated for by the smaller evaporation from the soil under forest cover than from the soil in the open. The forest soil gives up water to the air more slowly than either brush land, meadow land or cultivated fields.

Both observation and records show that forests powerfully affect the manner in which water reaches streams and passes down them. The forest floor is a blanket, and like a blanket it will hold more water than will the harder and relatively less porous soil of the open. A forest soil when saturated will hold more than half its dry weight in water, or over six inches of water to every foot of soil. This, as well as the breaking up of forest soil by the roots of trees and undergrowth, makes it more effective

than any other cover for the taking up of water into that underground reservoir from which all streams and springs are fed.

Too, as the forests have disappeared the territories covered by our summer thunderstorms have been gradually and greatly decreasing. During the last few hot seasons a few thunder clouds have been seen, but instead of increasing so as to cover more and more land, they became smaller and smaller and soon disappeared. This decreased the rainfall of the area.

The presence of forests also tends to add to precipitation of the summer months, by causing secondary showers after the main storm is over. The large leaf surface covered with moisture from the rain just passed, causes a rapid evaporation to take place almost immediately.

Forests also serve as windbreaks and keep the wind from taking the moisture from the country beyond, and that keeps the temperature lower. In hot weather, when the leaves and ground are full of moisture, it naturally cools off the air. From six hundred to nine hundred pounds of moisture is evaporated from a moderate sized birch tree in twenty-four hours, and as much as several tons from a large elm tree in the same time. The same amount of moisture is evaporated from other trees in comparison to their sizes.

Forests by means of their foliage break the sun's rays from the soil completely in some places and partly in others, and thus limit evaporation. Experiments have proven that the amount of evaporation is least under a forest and greatest in an open field.

When a forest is cut away the most evident fact is the admission of sunlight to parts that were shaded before. The result of this change is that a series of plants either die immediately or exist feebly for a few seasons and then die. The lack of plants is, after all, the most fatal to animals, since plants, and plants alone, can furnish food to animals. The existence of animals in any region is fully dependent upon the food supply, and any change in the quantity or quality of the food supply has a quick response in the animal life of the area. So when the plants of a region change, the animal life changes also. Thus we see that it is necessary to keep our forests if we wish to keep our animals.

Birds also cannot live unless we protect our forests, as they have to have a place for their homes. Many birds have left because their shelter and food are gone. Birds have such close relations to agriculturists, that anything which will increase their

numbers will be of great value. The birds check two of the greatest enemies of agriculture, noxious insects and weeds. If insect-eating birds were destroyed there would be a noxious insect to every square inch of land from the Atlantic to the Pacific, within a single year.

Our industries which subsist wholly or mainly upon wood pay the wages of more than 1,500,000 men and women. The industries which use wood wholly or mainly in manufacture represent an investment of over $2,250,000,000 and yield each year products worth nearly $3,000,000,000.

Forests afford logging camps, sugar camps, saw and planing mills, carpenter trade and the manufacture of furniture, besides many other industries. The by-products are wood alcohol, charcoal, dyes, foods, fuels, soda, lye, medicines, etc. The forests are full of trees whose bark is used for medicines, and when it is properly cut it will grow again and give more medicines. Besides the tree barks there are valuable herbs, leaves of trees and plants, roots which only grow in dense forests and for which there is now no known substitute. Thus we see that if the forests are cut, hundred of druggists will have to give up their trade, as there will be no material for medicines. Men are also employed to watch the forests to see that no ranchers or shepherds let their cattle graze in the forests and to stop the fires if there should be any.

Many of the streams, flowing down steep beds, at one time furnished valuable water power, but are now useless. Streams that thirty years ago furnished abundant water power ten months of the year are now without flowing water for almost half the time.

Drying up of the streams causes the destruction of our young fishes upon which the most highly prized fishes feed.

Forests are also very healthful to people, as the plants and trees take up the carbon dioxide, which is poisonous to animal life, and after it goes through the chemical process of the tree and leaves, it becomes oxygen. The leaves of the trees act as little lungs.

Thousands of people are benefited by the health-giving atmosphere of pines, the relief of sufferers of hay fever and asthma being specially marked.

MURIEL KINNEY,
Elkhart, Ind.

Seventh Grade.

FOREST INFLUENCES.

Our grandfathers in their efforts to make "clearings" for their corn and wheat, gardens and log cabins, labored diligently for years to chop down every tree, yea, every shrub and sapling on their property. So little appreciation had they of the real value of the trees that they often made rail fences of walnut, or used cherry for firewood. Now after all these years what is left? Nothing in almost all the settled districts, but a few scanty woods scattered over the face of the land.

Any country is always greatly in need of forests. Not only do its people need building material, but, more important, they need protection. Was not the great flood of 1913 which brought so much death and damage partly due to the lack of forests? Yes! For if there had been great forest areas these would have held the water, allowing it to pass off gently instead of rushing off in the fierce floods. After these came the droughts. They also were caused by the lack of forests. On account of the immediate run-off, there was no moisture in the soil to rise and return as rain. Not only was the life of the farmer in danger from the flood and his land parched with thirst, but the good soil from the hillsides of his farm was washed off, leaving little in many places but the rocks.

Forestry has an immediate effect upon rainfall and evaporation. The winter snows and the spring rains have saturated the ground. The mulch of loose soil and fallen leaves is filled, and also helps the earth beneath to retain its moisture. Summer comes on with its burning sun to parch things. The forest shade keeps the sun from drying out the floor beneath. The great trees, however, needing water, take it from the damp blanket spread over their feet and pass it on by evaporation to the atmosphere around A great beech or an elm, it is estimated, will give into the atmosphere over a ton of water in a day. So the forests become reservoirs which feed out slowly. The atmosphere is filled with the moisture given off by the forest, and when a cloud is passing over it becomes charged with moisture and a rainfall results. If there is no moisture in the atmosphere, what little there is in the cloud will be retained. In this way, a forested area causes more rainfall than a deforested one. A forested area, also, may cause a more gentle rainfall than a deforested one. The latter may become very hot. The heated air above it ascends. In its ascent it becomes cool, rapidly evaporating the moisture which it holds.

This will cause a downpour. Of course this could not happen in a forested area, for the forest makes the atmosphere cool.

Forests also have some effect on the temperature. During the summer days, when the air is warmer than the tree tops, it is cooled by coming into contact with the cool leaves and twigs. As it cools, it gets heavier and comes to the ground. Warm air moves in to take the place of the cold air which flows along over the surface, causing local breezes. At night the currents of the air change. The air in the forest is warmer than that outside because the woods, acting as a cover, prevent the radiation of heat. Thus the cold air moves from the open country into the woods. This is usually found true in the summer, although on winter nights the air in the tops of trees is a little warmer than that of the surrounding country.

Animal life also is somewhat affected. In the time of floods the rivers overflow and many fish washed out over the banks are left to die upon the retreat of the waters. Then in the droughts that follow, the streams and ponds which the fishes inhabit dry up, and others die. In flood time disease as well as danger threatens the livestock. The following droughts cause the grass to be dried up so that pasturing is unsatisfactory.

Then come the birds. What would they do without the great sheltering forest trees to offer them home and protection? What, too, would we do without the birds? The person who has not thought about it, questions their usefulness. He says, "But how do the birds help us?" True, you may say they come and eat your corn, but that is a very small matter beside the damage that the worms they eat would do. The forest offers protection for the animals also; the rabbits, the squirrels, and numberless others.

Everything depends on something else, and as we have seen, many things depend on the forest. Trees give us fruit and nuts and furnish many people with food. Trees give us turpentine and rubber and each of these makes an industry. The great gift of the trees to industry comes, however, through the forest in the shape of lumber. There are two kinds of lumbering—conservative and ordinary. Conservative lumbering is different from ordinary lumbering in these ways: the forest is used as a working capital for the purpose of producing successive crops, the mature trees are taken out without injuring the growing ones, and with as little injury to the undergrowth as possible. The need of this care will be seen when the fact is considered that in order to

supply our needs in the way of lumber for railroad ties and telegraph and telephone poles there ought to be a tree growing at each end of every tie, and five trees in advancing ages ready to take the place of each pole.

It would be difficult to make a list of the uses to which we put lumber when it finally comes to us after its long years in the forest. It gives us our homes and furniture and I am sure we would not get along without them. Commerce greatly depends on the forests. We must have wood to equip our railroads as they carry our goods to or from the ships. We must have wood to build the ships to carry commerce on the oceans.

"What do we plant when we plant the tree?
We plant the ship that will cross the sea.
We plant the mast to carry the sails;
We plant the planks to withstand the gales—
The keel, the keelson, the beam and the knee;
We plant the ship when we plant the tree."

Farming could not be carried on without the forest. How could the farmer get along without wood? He must have barns for his cattle and horses. He must have granaries and silos for storing the crops from his fields. He must have fences to keep the growing crop from destruction. He must have machinery, not only to plant and fertilize, but to till and harvest the crop. He must have wagons to haul his produce to the barn or to market. He must have fire to keep him warm and to prepare his food.

Forestry somewhat influences sanitation. As the leaves of the trees live almost entirely on carbon dioxide, they absorb that which is in the air. When they throw it off it is oxygen. The rainfall, also, which is a great cleanser, is made greater by the forest. The fallen leaves lying on the ground absorb impurities, making better soil.

We should learn to get our lumber without diminishing our supply of trees. For every tree that is cut down another should be planted. We should be very careful to protect all the trees until they come to full growth. It would not only be a help to the country but a source of pleasure to ourselves. What is more delightful than a day in the woods? Nothing; for in it is nature and everything that may make one happy. What is more refreshing than a rest from the heat under the shade of a fine tree? The man who cuts a tree out of the landscape ought to ask himself

as he thinks how long it will take him to destroy it, "How long did it take nature to grow this wonderful thing?"

"What do we plant when we plant the tree?
We plant the houses for you and me.
We plant the rafters, the shingles, the floors,
We plant the studding, the laths, the doors,
The beams and siding; all that be;
We plant the house when we plant the tree.

"What do we plant when we plant the tree?
A thousand things that we daily see;
We plant the spire that out-towers the crag.
We plant the staff for our country's flag,
We plant the shade, from the hot sun free;
We plant all these when we plant the tree."

MARY WHITE,
Bloomington, Ind.

Eighth Grade.

FOREST INFLUENCES.

One of the greatest questions before the civilized people today, and especially those of our own country, is in reference to the influence of forests upon rainfall, temperature, industries, animal life and sanitation. Also the preservation of forests is being taken up and action is being taken toward a system by which our forests may be preserved. Some of the most important influences which the forests exert are as follows: First, their relation to rainfall. The amount of rainfall and snow which is prevented by a forest growth from reaching the soil varies considerably according to the nature of the precipitation and the kind of trees which form the forest.

Also the density and age of the forest growth must be taken into consideration. If the precipitation is in the form of a light drizzling rain and only lasts for a short time the moisture may be almost entirely intercepted by the foliage and returned to the atmosphere by evaporation. If the rain continues the water will run off from the foliage and down the trunks. The form and intensity of the precipitation and also the condition of foliage have much to do with the amount of moisture reaching the soil. If the forest growth is very dense and the precipitation is very light, a very small quantity of moisture will reach the soil. But

if the growth is very sparse, the greater part of it will reach the soil. The climatic condition will have to be taken into consideration, also, in determining the amount of moisture which is intercepted by forest growth. The kinds of forests also determine the amount of precipitation which is intercepted. The loss by evaporation after the water has reached the soil depends upon the condition of the temperature and also upon the amount of direct insolation of the soil. If the atmosphere contains a very large amount of moisture, there will be less evaporation, but if the atmosphere is very dry and hot winds are blowing, the amount of evaporation will be exceedingly great.

Also in the case of evaporation we must take into consideration the height of the trees of the forests. The temperature under forest growth is generally not so warm as that outside and there is almost always a supply of moisture in the air. The trunks of the trees serve as a wind-breaking power of the forest and they must be considered as among the most important factors of water preservation.

The forest cover decreases the amount of evaporation within the forest and as a result increases the available water supply. In order that the process of transpiration may go on the sun has to play its part. Transpiration takes place in the green parts of the plant and, as has been stated, it can only take place during the time when the sun is shining. The process of transpiration is the getting rid of the surplus supply of water after the plant has taken it up from the soil and extracted the plant food which is held in solution in the water. Transpiration is dependent on the stage of development of the plant, on the nature of its leaves and the amount of its foliage, on humidity, on temperature, on the temperature and structure of the soil, and on the circulation of the air and the intensity of the sunlight. Taking all these conditions into consideration, we see that there is a great variation in the amount of water that is transpired.

Some of the conditions have a greater effect upon the process of transpiration than others. But there is still to be considered a certain amount of moisture which is stored up in the plant for a permanent or temporary constituent. This moisture is given off when the plant dies. Many things have to be taken into consideration in determining the amount of moisture thus retained. The total quantity of moisture returned to the atmosphere from a forest by transpiration and evaporation from the trees and

the soil is about seventy-five per cent. of the precipitation. In determining the absolute humidity within a forest we have to consider the kind of trees that go to make up the forest growth. The absolute humidity within a forest exceeds that of the glades and plains by a small quantity. Trees add a little to the precipitation which reaches the ground by condensing dew, frost and ice on their branches, and also by preventing the rapid melting of snow under the forest cover. Thus we see that by deforestation the climatic conditions would be affected which are the links of the chain which holds in its grasp the growth of civilization. The conservation of the water supply in forest growth is attributed to several causes. First, by the law of gravitation. Water filters through the cover of the forest floor until the whole mass has become fully saturated. Then if there is a sufficient supply of precipitation the water will filter through to the soil.

Then when the soil has become so saturated that it can hold no more moisture the cover will refuse to convey the supply and will shed it superficially. When the water supply ceases the process of evaporation will begin above the cover of the forest floor and by capillary attraction the cover will supply its loss of water on the soil which has been evaporated from the soil below.

Then the temperature of the air within the forest and the density of the growth play a great part in the conservation of moisture. The structure and relief of the forest floor must also be taken into consideration in discussing conservation and its attributes. The cover of the forest floor keeps the underneath soil very porous and thus it affords protection against the compacting of the soil by the falling rain drops. It permits ready percolation and as a result there is less water near the surface to be evaporated. Also when the forest growth is dense the winds cannot play their part so readily and the shade acts as a force in the process of conservation. The tree and its foliage serve as a cover for the space underneath the forest growth. Of course, the season, the nature of the growth and the precipitation have to be taken into consideration. If the growth is very dense we cannot expect so much moisture to reach the space underneath, especially when there is much evaporation taking place.

Many experiments have been tried and all have proven to some degree the fact that forest growths have a tendency to cause a heavier fall of precipitation. The forest air is cooler in the summer time than that on the outside, and when the storms ac-

companied by strong winds pass over the forest the force of the winds is checked and then the cooler air, acting to some extent upon the warmer air, tends to condense it. Thus we see that the forests have some influence upon the precipitation of a region. They serve the same purpose as a mountain does if they are scattered over a vast territory and are fully developed. In winter the snow is caught temporarily by the forest and let fall later upon the forest floor after having been melted. It is held longer in the forest and its melting is retarded, thus giving longer time for filtration into the ground. The snow keeps the forest floor from freezing to such a great depth as that outside and thus keeps the drainage system in the best order for the spring flow. The relief and structure of the land must also be taken into consideration in discussing the relation of forests to snow. The soil cover has little influence in determining where a spring shall be located. This is left wholly to the structure and topography of the soil and rock strata. A spring is water which has penetrated the soil and reappears collected on the surface. Springs are in most cases the beginning of brooks and rivers. There are several different ways in which springs are formed, but the one that is mostly affected by a forest cover is the surface spring. The place where it is discharged and the underground run is very short and lies near the surface. Thus, since the forest growth prevents evaporation so readily it would reduce the discharge of water if it were removed. The nature of the soil and soil cover and topography determine the amount of water that will run off and the nature it shall be. The topography also determines the rapidity of the run-off and of the collection. A forest growth has a tendency to retard the flow of water. Even the foliage retards the flow before it reaches the soil, and then the trunks and stumps of trees retard the flow also. Thus we see that it takes water longer to flow from a forest-covered slope than it would from a bare one. Then we might say the forest floor and growth have a saving influence in regard to water.

The forests have a great influence over the flow of rivers. They are the most valuable agents in preventing destructive floods. The forest has a cooling effect upon the soil and this is due to the shade and the supply of moisture in the air. The extremes of temperature within the forest occur much later than they do in the open and are greatly reduced, especially the extreme summer temperatures. The kinds of forest growth have to be considered

in relation to this subect. Also the age of the forest enters in as an influence upon the temperature under forest growths. The mean temperature of the air in the tree tops after correcting for elevation above ground is rather higher than that over the open fields. The total effect after taking in all conditions is a warming one. Certain kinds of forests show less difference between temperatures in the crown and below than others. The temperature at a considerable height above the forest is slightly affected by the growth, and more in the case of evergreens than in that of a deciduous growth. The wind does not affect the temperature above tree crowns as it does under and within the crowns.

Thus we see that as a consequence of deforestation we would expect an effect upon the climate of the deforestated area. First, we would experience the extremes of temperature of air and soil, and then the average humidity of the air being lessened and possibly the distribution and quantity of precipitation being changed. There is a very great difference between tree and air temperatures. The trunk of a tree is a very poor conductor of heat and as a result we would not expect an access of heat to the interior of the tree. The foliage of trees is arranged for the exchange of heat. The temperature of the leaves of a tree falls several degrees below that of the open air, on clear summer nights, and then rises to several degrees higher in the sunshine.

The average temperature of foliage has been found to be lower than that of the air about it.

The air in the forest is cooler than that on the outside and when the outside air current is retarded by the forest growth, local air currents are set up by the difference in temperatures and as a result it can be of influence upon the temperature and moisture conditions of neighboring fields by moderating temperature extremes and increasing the humidity of the air. It is not definitely known how far away from the forest this circulation of air becomes sensible, but it is only noticeable in the summer time. The forests have a great influence upon the climate of the soil. Sunlight is not admitted, moisture is stored in the soil and the forest floor covers the soil beneath the growth.

The soil is more slowly warmed by the sun than is the air and when it has once been warmed the passing and rapid changes do not affect it. The temperature in a forest glade seems to be a little warmer in the day and a little cooler at night than that under trees and in open prairies. The primeval forests of Amer-

ica were unexcelled anywhere in the world at the time of the first settlement of this country. They stretched practically unbroken from the Atlantic half way across the continent to the ninetieth meridian. Then forests covered about eight hundred and fifty million acres.

They were remarkable not only for their vast extent, but also for the great number of valuable species composing them. In these forests were trees of great age and enormous size. The American people have been drawing upon these forests for four centuries and they have constituted a source of great wealth as well as being an important element in the internal development of the country and in the extension of its commerce. One reason why our forests are no better today than they are and cover no more territory than they do, is because of the fact that when the settlers first came to America they cleared the land for agriculture.

Then as the population grew a great demand confronted the people for forest products and thus they began cutting the timber on a very large scale. No care was taken in trying to be saving with the supply, but the very best trees were chosen and half of these were left in the forest to decay. The portion left to decay would be far better than most of our supply today. Then fire has played great havoc in destroying our forests, and also the damage done by insects must be taken into consideration.

As a result of the work of all the enemies of the American forests we have left only a small area of valuable timber land and the supply is still decreasing so that we see it will be but a short time until the destruction of our forests is completed. If greater care had been exercised in the cutting of our original forests we would not be in such a condition as we are in regard to timber supplies. It is estimated that the forest productions can only continue for another generation in the United States. The demand is so great that they are rapidly being destroyed. The forests have been one of the greatest influences in bringing the United States to the position which she holds among the powers of the world today. There has been no substitute found yet that can take the place of timber in all cases. Of course, iron and steel are being used extensively, but they cannot compete with timber in regard to value. In the lumber business many thousand men are engaged, and if the forests cease to exist there will be out of employment a greater part of these men. The total value of timber consumed in a single year reaches many millions of

dollars. Many cities owe their growth to the lumber industry, because they first started to grow when only logging camps.

We see the fate awaiting us if we do not do something. In all the highly civilized countries people are trying to find some means by which they can preserve the forests and make them still productive in the coming generations. This is a very difficult task and much influence has to be exerted in order to bring about any result.

Then the problem before us is to help to bring about a change in regard to our forests. Another great loss which has taken place along with the destruction of the forests is the extermination of the animals which originally existed within their limits. Of course, we have some of them yet in the forests, but their number is in proportion to the size of the forests. And yet the greatest loss is that we do not have the variety of animals which we had when the forests were unbroken. Animal life as it exists today is of a rather domesticated nature. In the time of our forefathers when the forests were in their primitive state we could look upon animal life as being in a very wild stage. Of course, we had to exterminate some of the animals in order to do anything in the way of domesticating and caring for the less wild animals.

The animal life as well as forest products was a source of supply to our forefathers and it is one of the greatest today. If we should undertake to compare the number of varieties of animals as they exist today and as they existed three or four centuries ago, we would find that a very great number have been exterminated.

The forest was a home, a shelter and a food producing region for animals in the time of the early settlements of this country. The animals enjoyed the real nature of their lives to the fullest extent and it was not retarded until the intervention of the white man and the Indian. In man's work of destroying the forests he has likewise destroyed animal life. We know this to be true and can safely say that it has been the work of man that has brought it to pass. When the forests were destroyed the animals lost their homes and as a result they themselves were destroyed. They were just like man in that regard; they will fight bravely for their homes, but when they fail to hold them they are easily overcome and exterminated. Animals, as before stated, have been a source of supply to man since his coming in contact with them, and it seems that they always will be, so long as they continue to exist.

Forests also have been a source of supply and the two taken together constitute man's greatest source of supply. If by the destruction of the forests we think that we can hold the animal life in our grasp we are greatly mistaken, because by the destruction of the former we are sure to bring about the destruction of the latter.

Although we have some animals that will exist outside the forests, they would be affected to some extent by the destruction of the forests. Man cannot invent a way by which he could maintain animal life after the forests have been destroyed, because there is no other means by which animals may exist profitably. They look to the forests as their main place of safety. We see that when the forests are gone that the animal life will cease to exist also, and now the question is, What are we going to do when both are gone? This is a great question and should be thought upon sincerely, because it will be a great loss to mankind to be without these two great sources of supply, and those especially to which he had always been accustomed. The influence which forests exert upon sanitary conditions is very interesting and is being discussed and entered into more fully than in former times.

The condition of the country in the time of our forefathers was of the best kind, taking the country as a whole. It was far better than it is now. Instead of the everstretching area of the great forests we see large cities and deforested areas composing farm lands, and in many cases land that is scarcely of any value at all. In the time of the former there were not so many diseases as there are now, and although man is becoming learned enough to blot out most of these present day diseases, we can lay the blame upon the deforestation of the country. In order to understand why this is so we must note the conditions relative to forest influences. First, and most noteworthy, is the fact that the forest air is free from injurious gases, dust particles and bacteria. The protection against sun and wind and the consequent absence of extreme conditions in temperature is favorable to sanitation. The soil conditions of the forests are of such a nature as to be unfavorable to the production and existence of pathogenic microbes, especially those of the cholera and yellow fever.

Since the wind is absent in the forest to a great extent, and likewise the absence of dust particles, the microbes which are carried by the wind and dust cannot enter the forest. A good example of the forest influence in regard to sanitation is in the case of villages

in India which are surrounded by forests. Cholera never visits these regions. Forests breathe just like other plants and consume the carbon-dioxide and exhale the oxygen. It is estimated that the oxygen exhaled by ten and one-half acres of forests would furnish the required amount for four persons.

The air in the forests contains more carbonic acid than the open and this is due to the decomposition of litter. The soil in a forest contains less nutritive matter for bacteria growth, such matters as albuminoid, potash, phosphates and nitrates being nutritive to the growth of bacteria.

Also the temperature of the forest soil and air is antagonistic to the growth of bacteria. As before stated the drainage system in a forest is arranged in the best order and as a result no disease germs can exist so easily where the drainage system is so complete. As we said, the forest is a non-producting dust agent and we see that the air is not affected by that certain agent. The gases which are prevalent in the cities do not exist in the forest. The gases that arise in the city have been found to be dangerous to the health of the inhabitants. The forests, then, are the places of refuge from these dangers. Taking all the points which I have tried to discuss in a very brief way and summing them up as a whole we see that the forests are one of the greatest resources in existence. They are worth more to the human race today than any other resource known to man. They exert five great influences, their influence upon rainfall, temperature, industries, animal life, and sanitation. Their influence upon each is very noticeable and is of great value. The question before the people of today is how they are going to preserve the forests. By the total deforestation of the country great changes will come about and man will sustain a very great loss.

GLENN BOND,
Senior. Nashville, Ind.

The State Fair Exhibit for 1914.

The Board of Forestry gave its second exhibit at the State Fair September 7-11, 1914.

Owing to the limited space allowed for that purpose, the board could not make as extensive a display as anticipated, but hopes to make such arrangements for the future that an extensive display representing every phase of forestry in Indiana may be made in 1915.

The board desires to extend its thanks to the manufacturers and others for their coöperation in making the exhibit a success in the past, and believes that in the preparation for a larger and better exhibit, all who are interested in forestry in any way will contribute to its success by helping in whatever way it is possible to obtain the material and preparing it for the exhibit.

The board employed Robert S. Spray, G. E. Firestone and Miss Stella Howard to assist the secretary at the State Fair with the exhibit, who explained to the many visitors the work of the Board of Forestry in the past and what the board expected to do in the future to awaken the people to the necessity of not only taking care of the few remaining forests and woodlots but to induce a greater desire for planting non-agricultural lands to trees adapted to such lands.

Many visitors expressed themselves as highly pleased with the exhibit and requested that the reports of the board be sent them for information. From the many requests received it is evident that the interest in the work is growing and that the people are anxious to help in the work of reforestation.

A Farmer's Woodlot.

By request of the Secretary, Mr. Percival Brooks Coffin has kindly furnished this department with a statement of how he cares for his woodlot near Williamsburg, Wayne County, Indiana. This communication is published to show how easy it is for anyone who owns a woodlot to carry out many experiments in forestry and thereby not only help in the great work now going on but add to the beauty and value of his farm at the same time.

"After my talk with you this summer it occurred to me that you might be interested in knowing of the experiment that we have been attempting with a woodlot on our farm in Wayne County, Indiana.

This farm of seventy acres is located in Webster Township, Wayne County, Indiana, nine miles northeast of Richmond, Indiana. It is on the watershed between Nolan's Fork on the east and Green's Fork on the west, both tributaries in Whitewater River. The two brooks, which give the place its name, enter from the north, meet about the middle of the farm, and leave it in the center of the south line. They empty into Nolan's Fork. This farm is about 1,170 feet above sea level, and the soil is known as Miami loam. The land rolls very gently.

The farm is divided into five fields: First, to the east, comes the woodland of fifteen acres; next, west of it, the house lot and orchard of ten acres, bounded by the south field of thirteen acres, the north field of thirteen acres; and the west field, beyond the brooks, of nineteen acres. The farming land is under a high state of cultivation and well *tiled*. The west field contains a gravel pit, and there is a spring of flowing water near the house.

The Woodland.

This woodland is eighty rods by forty rods. The north end is highest. It slopes to the west and south to Brook No. 2 on the west and a marshy place bordering it.

The south one-third of the woodland has been divided from the balance of the fields by an old fashioned rail fence. When this

fence was built and this part of the woodland segregated as a laboratory, the entire woodland had been pastured, to my knowledge, for over twenty-five years, and was well seeded in blue grass, and contained but little undergrowth, most of which was stunted thorns, wild roses and osage orange bushes; however, the lot contained 179 trees of substantial size, many of them from twelve inches upward in diameter. The predominant tree was the white ash, shellbark hickory, sugar maple and beech; there were two lindens, a dozen hop hornbeams, two blue beeches, a few bitternut hickories, two buckeyes, four black walnuts, one white walnut, one large black ash five feet in diameter at the butt, eight hackberry trees, ten elms, one butternut, one shagbark hickory, three wild cherry, and of the evergreens, four junipers only.

In March, 1908, across the west end of this tract which we now call the laboratory, we planted three rows of catalpa and three rows of locust trees. The entire western part of this laboratory was almost denuded of trees; at that time we thought these trees would in time shade the rest of the woodland, and they have now grown to the average height of twelve feet. We also mulcted, that year, twenty-four walnuts, and the resultant seedlings were transplanted into the center of the laboratory, in March, 1909, and have now grown to an average height of about 48 inches.

A Kentucky coffeenut thicket, containing about fifty or sixty trees about three feet high, is located at one end of the orchard. From this twenty trees were transplanted into the laboratory, all of which have done very well. No other work of any kind has been done, but the way in which nature proceeds to reforest the land is well shown by the list of young trees which we found on June 19, 1914.

Ash, White	Abundant	Coffeenut	Rather Common
Ash, Blue	Rather Common	Hickory, Shellbark	50
Ash, Red	1	Hickory, Bitter or Pignut	11
Ash, Black	3	Hickory, Shagbark	2
Elm, American	Abundant	Mulberry	6
Elm, Red	Common	Willow	4
Beech, Blue	Common	Thorn	Rather Common
Hop Hornbeam	5	Cherry, Wild	Rare
Maple, Sugar	Common	Juniper	8
Tulip	1	Catalpa	Common
Linden	Common	Locust	Common
Hackberry	Rather Common	Buckeye	2
Oak, Chestnut	2	Dogwood	6
Walnut	Rather Common	Butternut	2

Within a radius of six feet from one old stump we found the following seedlings:

White Ash, American Elm, Blue Beech, Coffeenut, Sugar Maple, Linden, Hackberry, Shellbark Hickory.

At one time this woodland contained a number of white, red and burr oaks, all of which had been cut before the place came into our possession. We planted oak acorns, but nothing as yet has come of our efforts. You will note that the only oak seedlings we now have are chestnut oak, which have undoubtedly come from a large chestnut oak in the field of a neighboring farmer, about 300 feet from our south line.

It is our plan to take young trees from our own laboratory to replace trees that have fallen and been used for firewood in that portion of the woodland where we pasture hogs and cattle; and also take such seedlings as we may want to plant in other parts of the farm.

We shall continue from year to year to plant locust and catalpa, hoping therefrom to raise on our own place sufficient fence posts for our own use.

This woodland is not being developed primarily for profit, but first as a scientific experiment to show how reforestation takes place, and a careful inventory will be kept from year to year not only of the trees but of the shrubs as well."

Lessons from the Forest.

W. C. GOBLE.

EFFECT OF LIGHT AND SHADE.

Let us visit a section of the woods where the trees have been in the path of a destructive windstorm and see what lesson we can learn. All the trees seem to have been blown down or broken over. It is a rough looking place, indeed. But if we notice we will observe a large number of young trees. Some of these had their origin from the stumps of smaller trees, but a large number, in fact the majority, started from seed. One patch of very small trees, apparently not more than six years old, attracts our attention. Two-year old seedlings abound everywhere. Scattered among the young trees are clumps of wild blackberries, raspberries and other shrubbery, and in some places the grass is trying to cover the ground. Everything seems to be struggling for existence, each to gain a little more soil and a little more light.

Over there is a dense growth of young trees three to eight feet high. Count them. There are eight live trees on one square yard; and there are evidences that there have been many more, as there are several smaller ones which are dead among them, so that the number was even a great many more some years ago. It can not be expected that all these will live and grow to any great size. A struggle has evidently been in progress. It is the survival of the fittest. Most of the trees must perish, while those left will be somewhat affected by the struggle. All the trees which die during the next decade are still using up food and water, much to the detriment of those which will survive, and the tops or crowns of these latter are crowded and are thus prevented from becoming as large as they should be.

In this old thicket where the trees are twenty to thirty feet high, instead of there being eight trees to the square yard, there are only about that number to the square rod. These saplings are slender poles, with little short crowns or tops of live limbs, and the greater part of the pole is bare; the few remaining lower limbs are all dead, most of them decayed, and not a few are already broken. Why is this? What has become of the limbs? The dense shade has prevented them from leafing out, and as soon as a limb ceases to produce leaves the tree quits feeding the limb. Then the limb

dies, gets dry, decays and eventually drops off. This is the method the sapling has of getting rid of its lower limbs. Now we can account for the long-shafted timber, with clear trunks, that we may see about the sawmills.

Nature uses this method to rid the tree of the surplus limbs and thus reduce the knots in our lumber. Thus we see that shading and crowding help as well as hinder our forests. They help by destroying the weaker trees, and by removing useless limbs, and by making our trees shoot up straight.

Do you think spruce and other tolerant trees would clean as easily as those we have been talking about? I hardly think so, for their very tolerance depends on the fact that their leaves can work in a dense shade. Since they do not clean so well would the timber cut from these trees be as free from knots as those of the pine or chestnut? When you are around a lumber yard try to find out how it is and see if you can explain it.

Another thing we may observe as we go about these openings and thickets is that the shoots from the smaller stumps of chestnut, etc., grow very long even during the first year. Many of these sprouts attain a length of more than four feet, and if we compare them with the seedlings it is quite evident that the sprouts are by far the faster growers. Some of the seedlings made ten to fifteen inches growth the first year, but the pine seedlings are scarcely more than three inches tall.

Let us examine the little trees three to eight feet high. It is not always easy to tell first what is last season's growth in trees like elm, oak and the kind, but in pine, spruce and similar trees, each year's growth is very noticeable. Young white pine has a candlelike tip, about a foot long, then a whorl of limbs, below this another straight, branchless part, and so on. Each piece between the several whorls of limbs represents a year's growth, and we call the tip end, or last year's growth, the leader.

Thus, in young conifers, we can tell at a glance how much the tree grew last year, the year before, and so forth. By looking over a number of such trees we can tell fairly well as to whether they have made a good growth or not.

By this lesson we find that conifers generally grow very slowly the first five years, and most rapidly when they are about ten years old. Trees also stop growing rapidly in height when they are about seventy-five or eighty years old. The hardwoods behave in a similar way, but their seedlings usually grow a great deal faster.

Some Preliminary Investigations with Regard to the Cultivation of the Black Locust in Southeastern Indiana.

BY GLENN CULBERTSON.

In the reforestation of the hilly lands of southern Indiana, the planting of the black, or common locust (*Robinia pseudo-acacia*) is believed by many to promise earlier and larger financial returns. Many groves of locust have been planted during the last ten or twelve years, not only among the hilly portions of the State but in other parts also.

PLATE 10. Showing the larger and least injured trees growing in more fertile soil of Charles Irwin's grove—seven seasons' growth.

The writer has for a number of years been studying the growth of the locust, both in groves planted by man, and in those of volunteer growth. In view of the fact that many of the citizens of our State are directly interested in the production of the locust, it has been thought that an investigation and a report as to the conditions of planting and the growth of this tree should prove valuable. With this in view a number of planted groves were visited, and many facts concerning the nature of the soil, drainage, method

of planting, cultivation, growth of trees, pruning, and insect enemies, were recorded.

In this preliminary paper, some of these facts are given, and some conclusions drawn, in cases where the condition of the groves warrant. It is expected that a continued study of the growth of the trees in these and other groves shall prove of great value in determining the best conditions for planting and the best methods of treatment of such plantings in the future. Brief descriptions of a few typical plantings in southeastern Indiana are given here and some conclusions drawn.

PLATE 11. Grove on north slope of Indian Kentucky Creek—seven years' growth, no care or cultivation, but vigorous and almost without injury by borers. Soil with an abundance of lime. On farm of John J. Denny.

On the farm of Mr. Charles Irwin, Madison, Route 4, are three groves aggregating some twelve acres, planted in April, 1908, hence at this time, October, 1914, showing seven seasons of growth. (Plate 10.) The soil of these groves is largely clay, being pure yellow clay to clay loam and of sufficient slope to be well drained on the surface. The soil was prepared as for corn, and eighteen to twenty-four inch young trees planted with the spade. They were spaced 3½ by 3½ feet, and cultivated five times the first season, but not cultivated afterwards. The height of the trees now varies from seven feet in the poorest clay to twenty-two feet in the best loam, with diameters ranging from one to three inches. The average is from 16 to 18 feet in height and two inches in diameter. Approximately sixty per cent. of the trees are living, although not

more than forty per cent. of those planted in the poorest soil are now alive. The groves were sown to orchard grass and have been pastured for three seasons. The locust borers have caused considerable loss, fully fifty per cent. of the trees being affected, and many dying as a result of their ravages.

On the farm of Mr. John J. Denny near Belleview, some three acres of locust trees were planted in the spring of 1908. (Plates 11 and 12.) The greater part of these were planted on the steep north slope of Indian Kentucky Creek, in a black loamy soil, derived from the decomposition of the Lorraine shales and limestones. The trees were planted with a spade, between the corn rows of the

PLATE 12. Another view of grove on lime soil of hill slope on John J. Denny's farm.

previous year's crop, without rebreaking. They were spaced 3½ to 4 feet, and no cultivation or care whatever given them. These trees average from 20 to 25 feet in height and from 2½ to 3 inches in diameter three feet from the ground. Fully seventy-five per cent. of the trees are living, and they have not been injured to any extent by the borers. Not more than five per cent. of the trees are at all affected, and those not at all seriously. The trees are holding the soil well, no erosion taking place, although the slope is one of 30 degrees or more and there is little or no grass present. The fallen leaves and twigs are beginning to form a soil mulch.

On the farm of Dr. C. W. Denny, also near Belleview, Jefferson County, is a grove of seven acres planted in the springs of 1906 and 1907, by A. W. Jessup. (Plate 13.) This grove was planted with the spade, after the soil had been prepared as for corn, and

the trees were placed 4 by 4 feet. The young trees were cultivated for two seasons, at which time the trees had a fine growth and the grove looked very promising. The soil of this grove is the typical bluish-white clay of the "flats", very level and with almost no natural drainage. The height of the trees in this grove after eight seasons' growth is 12 to 14 feet and the diameter three feet above the ground from 1½ to 2 inches. The per cent. of the trees living is not more than thirty-five, and the borer is at work in at least eighty per cent. of those remaining. The bagworm has also done some injury to the foliage for a season or two. The green brier and the golden-rod are growing more vigorously than the trees.

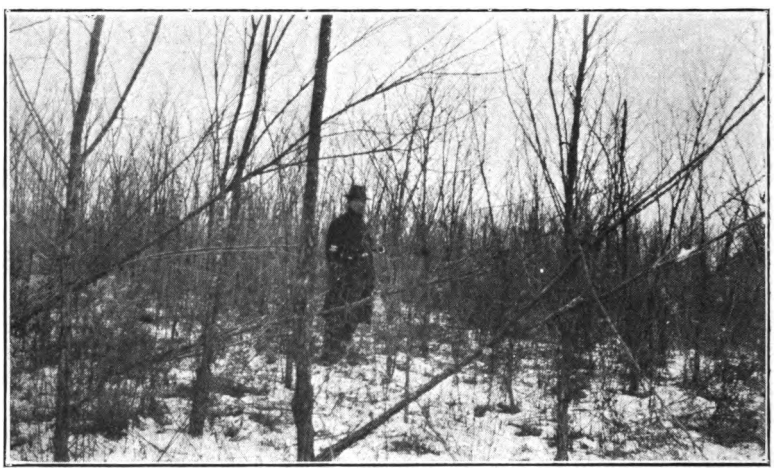


PLATE 13. Grove in sour, undrained soil of "Flats"—eight seasons' growth. A fine grove when two years old, but greatly injured by borers and very small and unhealthy trees now.

On the farm of George Black, near Kent, is a two-acre grove, planted in the spring of 1908 on red and yellow clay soil, derived from Devonian limestones and shales. The ground was prepared as for corn and the trees planted 4½ by 3½ feet in furrows laid off with a plow, and then covered with the same implement. The trees were cultivated one season and pruned once. The average height of these trees is 25 feet, although some on the poorest and dryest soil are not more than fifteen feet. The diameters vary from two to four inches, but will average slightly less than three inches. Fully eighty per cent. of the trees are living and the borers have done very little injury.

On the Hanover College farm a seven-acre grove of locust was planted some twelve years ago. (Plate 14.) The soil of this grove

is a yellow clay derived from limestone, and when planted had been too continuously cropped. The soil has sufficient slope to be well drained. The trees were planted in the usual way with a spade and in rows 10 by 5 feet. The trees have not been cultivated, nor have they been trimmed. The trees are rather widely branching and are about 25 feet in height and from three to four inches in diameter. In some of the more fertile soil the trees are from five

PLATE 14. Grove on Hanover College farm, planted 10 x 5 feet, showing more branches than in case of closer planting.

to six inches in diameter. Fully eighty per cent. of the trees are living, and the borer has done no injury. An enemy of the locust tree has appeared in this grove as in many of these along the Ohio River slopes, which may prove highly injurious. The new enemy is a beetle (*Chalepus dersalis* of Blatchley's Coleoptera of Indiana), and has destroyed the greater part of the foliage of the groves in many places during the past season.

In the groves described above we have locust plantings in the

leading types of soils found in southern Indiana, except the more sandy and the purely alluvial soils. It is too early as yet to predict the ultimate profits or losses derived from these plantings. It appears however from the seven-acre grove planted on the farm of Dr. C. W. Denny, that it is useless to plant locust on undrained heavy whitish clay soils. The soils of this part of Indiana commonly known as the flats or "crawfish flats" are not adapted to the growth of this tree. The above grove promising so much at the end of the second year's growth, now appears to be rapidly degenerating, and if left for fifteen or twenty years, will not in all probability repay the expense and labor of planting.

From the vigorous grove on the farm of Mr. John J. Denny, planted without previous preparation of the soil, and with no cultivation or care since planting, we judge that hill land with an abundance of lime in the soil, is best adapted to the growing of locust. Judging from the appearance of this grove and of many others of volunteer growth locust should do well on all the hill land of southeastern Indiana and probably of all portions of the State where sweet clover spreads and thrives. The locust, as almost all other legumes, seems to thrive best in soils with an abundance of lime and free from acid.

We note also that the injury caused by the borer is much greater in the less vigorous trees growing in poorer, acid soils. If the tree is vigorous, growing rapidly, the borer will not be of great injury, but will completely destroy groves not favorably located as to soil and drainage.

Our observations lead us to believe that trees on the best soils should be planted not closer than 5 by 6 feet, while on soils not so well adapted to the locust, 6 by 7 feet is probably close enough. In the Hanover College grove, where the planting is 10 by 5 feet, the trees are too widely branching, and have not sent up straight trunks of sufficient height. Sowing to grass and pasturing, at least until the trees have attained a comparatively large size, is probably injurious inasmuch as the grass uses much of the moisture that should be left for the growing trees.

While the locust plantings above mentioned are not yet sufficiently developed to predict accurate results as to profits, enough is indicated to lead us to believe that many thousands of acres of the hill lands of southeastern and southern Indiana, rich in lime and subject to serious loss by erosion should be planted to locust trees, and that the profits from such plantings would prove highly satisfactory.

The Wood-Lot Problem.

BY STANLEY COULTER.

In a series of articles[1] previously published in the reports of this Board an attempt has been made to call to the attention of landowners the economic significance of the wood-lot, and to indicate the extreme importance of what may be called the wood-lot problem. Because of the large number of letters received bearing upon points discussed in these articles it has been thought advisable to again present the matter in a modified form and from a slightly different angle.

Certain facts should be kept clearly in mind in any discussion of this problem, since it is only through a recognition of existing conditions that we can hope to develop a rational system of wood-lot management. These facts may be summarized briefly as follows:

As late as 1890 Indiana was one of the important lumber producing States. At present it is not "placed" in the government reports but is classed among "all others," a classification showing an astonishingly rapid depletion of our forests.

The industries of the State using wood as raw material, either wholly or in part, have, within the same period, decreased rapidly both in numbers and in amount of capital invested. Those which are still operative secure by far the largest part of their supplies of raw material, usually in log form, from other States.

About four million acres of land in the State are classed as wood-lots, and this area, because of agricultural demands will be far more likely to decrease than to increase.

The existing wood-lots show almost without exception the following unpromising conditions:

1. They do not carry a full load of timber. Most of our timbered areas could carry four times their present stand.

2. The trees they carry are of poor form, branching low and therefore producing a poor quality of lumber, a condition due chiefly to the light stand.

[1] Wood-lot Conditions and Possibilities I: Rep. Ind. State Board of Forestry 1909, pp. 37-46.
Wood-lot Conditions and Possibilities II: Rep. Ind. State Board of Forestry 1910, pp. 126-135.
Suggestions for the Improvement of Indiana Wood-lots: Rep. Ind. State Board of Forestry 1912, pp. 85-106.

3. The species making up the stand are not of the best quality; on the other hand they are very largely decidedly second or third rate both as regards value and range of utilization.

4. The wood-lots are almost without exception badly in need of cleaning, for the removal of dead or dying trees; of those that are insect or fungus affected; of those that would never under the most favorable conditions reach a size which would give them a market value and for freeing the forest floor from litter and brush which prevent the possibility of the germination of seeds.

5. Very few if any of these wood-lots show any promise for the future, since through overpasturage, fire or other causes they are practically destitute of seedlings of desirable species. Unless an abundant supply of seedlings of desirable species is at hand to take the place of the older trees as they are cut, the end of the wood-lot is near at hand.

While it is true that improvement in the management of wood-lots has taken place in some cases within the past few years, the above statements represent fairly and without exaggeration the condition in the vast majority of the wood-lot holdings of the State. This summary has been given, not in the spirit of criticism or because it is believed conditions are hopeless, but in the belief that a full realization of the facts will give a new view point and lead to the formulation of a wiser management.

The landowner needs wood for an almost endless series of uses; for fuel, for posts, for occasional poles, for a host of small dimension articles and at times for lumber. The wood-lot should furnish all of these needs and free him from the necessity of purchasing them upon the market. It is just as essential that he should raise a crop of wood from the standpoint of a sound economy as that he should raise his ordinary agricultural crops.

Under our present conditions with such a large proportion of our population living in cities, it is absolutely necessary not merely that all of our land be utilized, but also that it be utilized to its fullest capacity and in line with its highest possibilities. This statement is so obvious that it needs no argument in its support.

When we have massed our facts in this way certain conclusions seem inevitable. We must classify our soils, using each type of soil in the line of its highest possibilities. Trees should not be raised upon corn land, since the annual crops of corn would give far greater returns than any timber crops that could be raised. The reverse of this, however, is true, namely that it is poor business

to attempt to raise annual crops upon purely forestal land. The United States is far behind in this scientific classification of soils, a fact which largely explains the surprisingly low average of our crops when improved methods of farming are taken into consideration.

As the area devoted to forestal purposes cannot in the nature of things be increased, as indeed it must almost inevitably decrease, it is evident that if the needs of our increasing population for wood and wood products be met that existing wooded areas must be so managed as to carry their maximum crop. Not only must they be so managed as to carry their maximum crop but the crop should be of the best quality and the best form. These things are absolutely essential if the wood-lot produces adequate financial returns at regular intervals.

It is also very clear that the wood-lot must be viewed in a new light—it must be regarded as a productive part of the holding, a part as productive as any other tract of similar area. If it is not the system of management should be changed, or the wood-lot abandoned.

The perpetuity of the stand and its continued productiveness must be provided for by some system of management which will produce a supply of seedlings sufficiently abundant and vigorous to insure the continued regeneration of the tract.

These conclusions not only simplify the problem but give direction to the individual landowner as to the best methods of managing his timber holdings. His motto should be *the greatest amount and best quality of timber possible, in the least time and at the least expense.* It is of course very easy to suggest such a motto, but the outlining of a plan for producing these very desirable results is an entirely different task. Nevertheless, there are certain very evident lines of procedure which are of universal application and may be first considered.

The first step is a careful examination of the stand as to its amount, its composition and its quality. At the same time it should be determined whether or not there is present a sufficient young growth to insure its perpetuity. Incidentally the amount and character of necessary cleanings should be considered.

The average forestal land in the State should carry from 7,500 to 10,000 board feet to the acre. In Indiana the Scribner-Doyle rule is commonly used. Under this rule, a twelve-foot log, sixteen inches in diameter inside of the bark at the small end will cut one

hundred and eight board feet. It would require approximately ten such logs to cut a thousand board feet. If the stand carried 7,500 board feet to the acre there would be at least seventy-five trees to the acre, each of which would cut a twelve-foot log, sixteen inches inside diameter at the small end. If the trees had the same diameter, but cut logs sixteen feet long, each log would contain one hundred and forty-four feet, or it would require seven such trees to make a thousand feet. With these figures in mind it is fairly easy to estimate the amount of the stand. In the great majority of cases, seventy-five trees cutting each one twelve-foot log, sixteen inches in diameter, or fifty-three trees cutting a sixteen-foot log sixteen inches in diameter will not be found. In such cases wise mangement looking to the maximum amount of timber as the end to be gained seeks to increase the amount of the stand by *re-enforcement*. Where the soil is fairly strong and desirable seed trees near, this may be secured by natural regeneration, provided the forest floor is in such condition that the mineral soil is within reach of the seedling. This preparation of the soil very frequently consists in nothing more than removing brush or cutting away weeds and undershrubs. In most instances, however, artificial re-enforcement is necessary, in which case either seeds or seedlings may be used. These are planted in the open spaces in the stand, the seeds being "dibbled in" and the seedlings set by the "slit method." Both of these operations are described in the former articles and reference is made to them for details. The prompt bringing up of the stand to its full load is usually inpossible without re-forcement.

A tree to be of good form from the lumber standpoint and indeed for almost any purpose, must have a clean trunk or bole free from limbs. Standard logs in our markets are twelve, fourteen, sixteen or more feet long. This standard determines the minimum length of clear bole for saw timber. The length of the clear bole for tie or post stuff is less, but is just as necessary for securing the highest price as in saw timber. In nature this clear bole is brought about by the shading off of the lower limbs, but this natural pruning will not take place unless the stand is so dense that each tree is crowded by its neighbors. Poor form is inevitable in light stands, a fact which furnishes an added argument for re-enforcement. It further serves to indicate that in re-enforcement the young seedlings should be planted in the open spaces in sufficient numbers to insure the development of

the desired form. In this work, however, heredity should not be left out of account. Trees of good form and rapid growth are more apt to be developed from seed derived from trees possessing these characteristics than if taken from those of bad form and slow growth. Recent and extensive experiments give striking support to this statement. Where the time necessary to produce a harvest is so long, even under the most favorable conditions, the greatest care should be used in the preliminary steps.

Unless conditions are exceptional it will be found that the proportion of species in the stand is unsatisfactory. Inferior species are present in too large numbers, while species of high value are characterized by their scant representation. Black oak is more common than white oak, cottowood and elm and honey-locust than walnut, cherry or tulip poplar. Even granting that these inferior species are present in fair numbers and in good form, it is evident that their aggregate value would be less than in a stand in which high grade species were dominant. This condition of course indicates a system of management, which in time will change the proportion of species. This change can be brought about by controlling re-enforcement. In artificial re-enforcement only desirable species are planted in the open spaces. The material needed from the wood-lot is drawn as far as possible from the less desirable species and the spaces formed by their removal planted with the species better suited to the purposes of the management. It is evident that increase in quantity, improvement in form and change of proportion in the component members of the stand, may all be secured by a wise plan for the re-enforcement of the present stand.

If the wood-lot is managed efficiently it will produce crops at regular intervals. If it does so it will be because all age classes or size classes are proportionately represented in the stand. This means that when the trees which are ripe for the axe are cut out there should be present a sufficient number of the next lower age or size class to take their place within a reasonable length of time. It is only when this proportion is present that continuous crops at regular intervals are possible. Since trees are subject to many dangers it is plain that the number in the next lower class must be greater than in the class which is being harvested. As we go lower in the classes the number of individual trees necessary to insure a full stand when at the age or size considered as ready for the market increases. Twenty-five hundred trees five to ten years old, of our ordinary hardwoods, to the acre would

not constitute an unduly dense stand. At a hundred years not more than eighty to a hundred trees could be carried to the acre. This is to show that in attempting to determine whether a sufficient young growth is present to insure the perpetuity of the stand a number of considerations enter. There must be taken into account not merely the number of young trees present, but their proportional distribution among the different size or age classes.

Now, it is just in this particular that the condition of our wood-lots is most unpromising. Only occasionally is young growth present at all and when present it is only imperfectly distributed through the size and age classes. The condition is one which can be remedied but slowly. Two obvious methods of bringing about a young growth are:

1. Relieve the wood-lot from the burden of pasturage.
2. By judicious cleanings put the forest floor in such condition that the germination of seeds is probable, and not merely possible.

The almost total absence of young growth from our timbered areas is very largely due to the fact that wood-lots are almost always used for pasture. Where grazing or rooting animals range there is no possibility of young growth being present in anything like the proper proportion. In the great majority of cases if the wood-lot were freed from pasturage an abundant and vigorous young growth would appear. Wood-lot and woods-pasture are held by many to be synonymous terms; as a matter of fact they are antithetical. A choice must be made by the landowner as to whether he desires to maintain a wood-lot or woods-pasture. In the one case the returns from the tract are in pasturage; in the other in wood and wood products. If he chooses one he must give up the other, for he cannot secure both from the same area.

It is recognized that in some types of farm management the woods-pasture is a necessity, but even in such cases it is a question if a certain part of it might not profitably be set apart for wood-lot purposes and part for pasture purposes with better financial returns than under the present method of handling which can have no other result than the speedy disappearance of the wooded area. It is very doubtful, when the cost of wood and wood products which he is compelled to purchase upon the market is taken into account, whether the landowner has practised a sound economy. It is almost certain that it will be found he has paid an extremely high price for pasturage. Any system of manage-

ment will be futile and utterly fail in the securing of adequate returns if the wood-lot remains a woods-pasture.

In very many cases the wood-lot has grown up more or less to shrubs and various types of underbrush. These growths appear as a rule in the open spaces. Where they have taken possession of the soil natural regeneration is practically precluded, since if a seed should by any chance manage to germinate, the resultant seedling would surely perish under the shade of the underbrush. The forest floor is also often more or less encumbered with brush and fallen logs. Where these occur regeneration is impossible. The landowner who realizes the financial possibilities of the wood-lot and who seeks to utilize all of the area for its highest possibilities would recognize that under such conditions cleanings were indicated and would institute such cleanings as one of his earliest operations. The first cleanings should perhaps go no further than this, for as indicated in the former articles cited, cleanings may be carried to such an extent as to result in damage instead of benefit. It is for this reason that it is suggested that the first cleanings be limited to operations looking to the utilization of the entire area by the preparation of the forest floor as a seedbed, along the lines indicated.

Before there can be any improvement in wood-lot management, present conditions must be understood. Each wood-lot owner should carefully study his holding in order that he may determine whether the above statements are true or approximately true in his case. Stated in another way, he should determine whether he is securing returns from his wood-lot comparable to those secured from other tracts of similar area. If adequate returns are not being secured a proper system of management should be devised or the wood-lot abandoned.

As a rule relatively short rotations for the production of small dimension stuff give the most satisfactory results in wood-lot management. This, of course, controls the selection of species for re-enforcing. In selecting the species the following factors should guide:

Adaptability to purpose.
Inherent value.
Ease of propagation.
Rapidity of growth.
Resistance to insect and fungus attacks.
Adaptability to local conditions of soil, moisture and exposure.

The needs for wood products upon the farm are varied and the wood-lot should be so managed as to meet these needs, and this means a relatively mixed stand. Catalpa is a rapid grower and furnishes high grade post material; it has, however, little if any fuel value. Yet fuel is a more constant necessity than post stuff. So, also, some of the small dimension stuff needed must have strength, a quality ordinarily not found in rapidly growing forms. It follows that in the successful management of the wood-lot of the average farm much attention must be given to the selection of species.

As between two species of equal rapidity of growth and of equal hardiness choice should as a rule be made of the one having the greater inherent value; that is, the one in which the structure of the wood or some property of the species fit it for valuable uses. The willows are rapid growers and above the average in disease resistance, but have little inherent value. The white ash is also a fairly rapid grower, is extremely resistant to disease and insect attack and has a high inherent value. As between the two no question should arise.

The wider the range of uses to which a given species is suited the higher its inherent value. Catalpa, for example, has its chief if not its only value in its resistance to decay in contact with the soil. Ash, on the contrary, can be used for a wide range of uses extending from tool handles to musical instruments.

Ease and certainty of propagation should also be taken into account in the selection of species. If the species selected are difficult to propagate, requiring constant attention and skillful care to bring them to maturity, financial failure will be the inevitable result.

Perhaps of greater importance is the selection of species which are naturally resistant to insect attack and immune to fungous diseases. In the main all healthy, vigorous and uninjured trees are practically safe from insect attack or disease, but in some species, because of habits of growth or inherited tendencies, there seems to be a peculiar susceptibility. Much black locust has been planted in Indiana within the past twenty years, because of its rapid growth, the ease and certainty of its propagation and its value for posts and similar uses. Locust, however, in our area is extremely likely to be attacked by borers, which in many cases destroy from thirty to forty per cent. of the stand. Indeed, in some regions of the State it is folly to attempt to grow this

species. Catalpa is another rapidly growing species which has been widely planted, yet in some parts of the State because of the presence of the catalpa sphinx its defoliation is practically certain each year, conditions which absolutely preclude any adequate financial returns from the investment. In any operation in which time is such an important element, too great care cannot be given to the selection of resistant species.

Each species of tree has its optimum conditions of soil, moisture and exposure. Where these optimum conditions are found in the same area not only is the growth most rapid, but the quality of the wood produced reaches its highest point. On the other hand, almost any species of tree is able to maintain life under any conditions likely to be found in Indiana. The ability to "keep from dying," however, is not enough. Unless the species grows rapidly and vigorously it will not prove profitable. Using as an example the two species so widely planted by our landowners, we find a great variance in soil, moisture and light requirements. Locust finds its optimum conditions in a loose, rather coarse soil which is well drained. It is an intense light demander and will hold its own and make a good growth even in very dry soils. The catalpa finds its optimum conditions in a rich loam soil, with abundant moisture. It stands a fair amount of shade especially when young, but will not make a satisfactory growth in a dry, compact soil. The unsatisfactory returns from the great majority of such plantings is easily understood when the requirements outlined above are taken into account.

No work looking to the improvement of the wood-lot by planting should be undertaken by the landowner until he is absolutely certain that the species selected are so adapted to the particular area as to soil, moisture and exposure conditions as to give promise of a rapid growth and good quality.

Very fortunately the experiments conducted at the State Forest Reserve have furnished us with a list of some of the species best adapted to wood-lot improvement under existing conditions. This information may be secured by any resident of the State by writing to the Secretary of the State Board of Forestry, Indianapolis, who will also give such additional information as may be desired.

Success in efforts to improve the wood-lot depends so greatly upon a wise selection of species that every effort should be made to secure all available information.

Enough wooded area remains in Indiana to maintain existing wood-working industries and to supply all of the needs of the farm, provided these areas are properly handled.

The wood-lot problem is becoming more and more important each year and upon its wise solution much depends. As it stands at present 4,000,000 acres of land are carrying no greater load than 1,000,000 acres should carry. This means that three-fourths of the capital thus invested is nonproductive—a condition which certainly indicates poor business management. This statement, true of the wood-lots taken as a whole, is true also of the individual wood-lot. It is an evidence of bad management or poor business ability, or both perhaps, to have any part of the land continuously nonproductive. The suggestions made in the foregoing paragraphs are for the purpose of indicating methods by which this nonproductive capital may be made productive.

Another fact is pertinent in this connection. Upon every farm are to be found areas, some large, some small, which are never cultivated. This may be because of character of soil, difficulty of drainage, topography, relative inaccessibility or any one of a large number of reasons. The fact remains that the aggregate of these untilled, continuously nonproductive areas taking the entire State into account, is positively appalling. These waste areas should, in every instance, be brought into productiveness as rapidly as possible. As a rule, their best values under existing conditions will be found to lie in planting to quick rotation wood crops. In addition to the re-enforcement and quality improvement of the existing wood-lot there is involved the extension of timbered areas by the inclusion of these untilled waste spots, which at present are not merely nonproductive, but which stand as a constant menace to successful agriculture through the harvests of pernicious weeds which they usually carry.

If any advances are made in the State in forestal practice, these advances will be made through the efforts of the individual landowner. The cost and the difficulty of administration preclude either the possibility or desirability of the State undertaking such work. The wood-lot problem in Indiana is to be solved by the intelligent and persistent work of individual landowners who seek to bring every square foot of land which they own into its highest productiveness. Unless the wood-lot is regarded as at least potentially productive, the case is hopeless.

In work so far-reaching and involving so many factors as full

knowledge as possible should be secured before operations begin. The work of the State Board of Forestry has been consistently along experimental lines. It has not attempted to raise timber upon the Reservation, but it has attempted, through its experiments, to answer the questions which necessarily must be answered if effort is made to improve present conditions. Through the results obtained in these experiments it is now possible to give definite and positive information regarding questions of procedure in all save the most exceptional cases. This information is at the disposal of wood-lot owners and will be furnished by the secretary of the board upon request, provided the conditions as to *soil, moisture, drainage* and *exposure* are clearly given. These factors are so dominant that unless they are given in detail it is impossible to give specific advice.

The wood-lot problem involves far more than the production of wood; it is a question of the full utilization of the soil; a question of diminishing the amount of non-productive capital, in short a problem in farm economics which should make appeal to every landowner in the State and lead to immediate and wisely directed effort.

The More Important Fungi Attacking Forest Trees in Indiana.

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It is a well known fact that the trees of a forest do not die naturally. Trees grow by the cambium forming new wood and bark tissue, and by new shoots. The cessation of growth of trees after they have reached a certain maximum size is attributed to interference with the factors of nutrition and the factors which are involved in the conduction of water and nutritive materials to all parts of the tree. This disturbance in the functions of the parts of the tree is not the result of "old age" but is due to the greater number of dangers with which the tree must contend. The death of parts or of whole trees is always due to unfavorable influences or conditions.

With increasing size of trees the number of injuries such as broken branches, insect injuries to the bark and the foliage, the greater are the possibilities for fungous invasion. The control of the factors which cause these injuries would in a large measure control the fungous enemies of the trees. Most of the fungi attacking the trunks of forest trees are known as "wound parasites." They enter the trees through some kind of an injury.

Some fungi, however, do not need injuries to aid them in attacking a tree. These are relatively few in number. Some attack and injure the trees when in the seedling stage only. These are of special importance in the nursery.

With increasing root development the soil becomes denser. This condition affects the entrance of air to the roots. The nutritive materials may also be partially exhausted. This reduction in the availability of the nutritive materials to the crowns of the trees affects them. They do not put out normal foliage, transpiration is altered, and as a result the tree as a whole is weakened. This condition is commonly known as "stag-headedness." Fig. 1 shows a stag-headed oak. Such a tree is predisposed to both insect and fungous attacks.

During the last three years I have been able to observe a number of wood-lots and have examined many trees both in the forest

and at the sawmill that were in bad condition. Many of the trees were wind-thrown. In Kosciusko county most of the wind-thrown trees were oaks. These trees had been badly heart-rotted. They had recently fallen in a severe windstorm during the early part of the summer of 1913. The study of these trees showed that they had not all been weakened by the same fungus. Some were

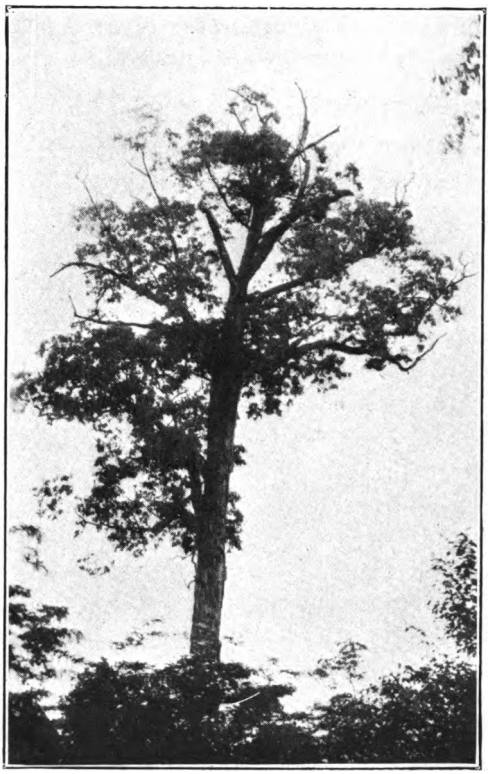

Fig. 1. A "Stag-headed" White Oak.

uprooted, others were broken at the butt, and some broken off at a distance from the ground.

In the vicinity of Lafayette many hickories are dying at an alarming rate. This is due to the Hickory Bark Beetle. Many of these trees are also attacked by the Honey Cap fungus, *Armillaria mellea* Vahl. This fungus attacks the roots of the trees, but I believe it is secondary in its attack. I have found none of this species on any trees except those that were either killed or dying. Frequently these trees are wind-thrown. I believe that the Honey Cap fungus is largely responsible for this.

It is a foregone conclusion that a tree is never free from pests of some kind. It is my purpose to indicate in this paper those fungi which I have studied and which have been reported as being parasitic in wood-lots and in forests within the State. For convenience of discussion I shall classify the fungi according to the parts of the tree attacked. I shall consider first, the trunk-attacking fungi; second, the foliage-attacking forms; and, lastly, the root destroying fungi. Following each group I shall indicate the control measures that have been suggested.

I. TRUNK-ATTACKING FUNGI—

a. *The fungi in general.*

Fungi may attack both the heartwood and the sapwood of trees. As a rule, the heartwood-attacking forms do not kill the tree directly. They weaken the tree and, as mentioned above, a common fate of the tree is to be wind-thrown.

Sapwood attacking fungi are less common. When infected the sapwood has been observed to thicken the walls of its cells in response to the action of the fungi and thus resist invasion. However, in dead trees the sapwood decays much more rapidly than the heartwood owing to the absence of encrustating substances which are present in the heartwood, and also because of the presence of more moisture and starch.

The fungi of both groups enter the trees through injuries. Borer-holes and all kinds of mechanical injuries to the trees are channels for entrance. Infection is performed most frequently by spores. The spores are the reproductive bodies of these fungi. They are formed in special fruiting bodies called sporophores. These sporophores in the case of most trunk-attacking fungi are tough-fleshy, or woody, in texture. They appear as brackets on the sides of the trees. They are variously colored. Some sporophores last for a single season, as those belonging to the genera *Polyporus, Pleurotus, Hydnum, Steccherinum;* or, they may be perennial, as *Fomes.* The former are fleshy and light colored; the latter are woody and are dark, usually some shade of brown.

The spores are formed in great numbers. They are very small and are constantly present everywhere. They are scattered by wind, insects and birds.

When the spores lodge in places where there is adequate moisture they germinate. If the substratum contains suitable and available nutriment they continue to grow and produce a mycelium. The mycelium appears as a dense cob-webby growth, commonly

known as "mould" on various substances. If inoculation has occurred in an injured place on a tree the mycelium will secrete fluids which will dissolve the wood tissue and decompose it. The fungus uses these dissolved tissues as nourishment. After the mycelium becomes well established in a tree it almost always puts out the sporophores.

Because of the constant presence of numerous spores everywhere, any injury to a tree permits the entry of some of these spores and infection is made possible. Prevention against this occurrence is the basis of all tree sanitation work. In tree surgery

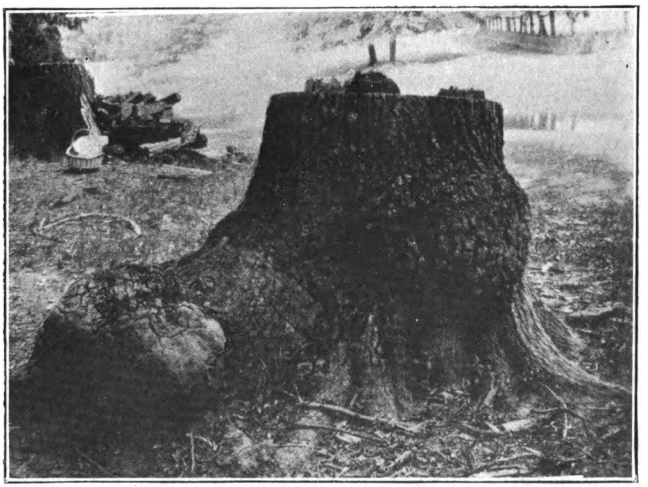

Fig. 2. Stump of a White Oak showing a butt-rot. The heartwood of this tree was completely rotted to a height of ten feet.

damage already done is removed and precautions are taken to prevent further entry of spores and subsequent decay.

One of the best preventatives is coal-tar. This painted over recent injuries will prevent the growth of any spores into the wood. However, if infection had already taken place, the decayed areas must be removed before painting. These cavities must be carefully cleaned and filled in with cement. When this is done with due consideration for the growing cambium it constitutes successful tree surgery.

The rate of growth at which a fungus spreads from a given point of attack in a tree is unknown. This rate is undoubtedly influenced by the predisposing factors acting upon the tree. Older trees seem to be more readily affected by disease. Infection very

often can not be noticed until it is too late to save the tree, or to prevent at least, extended decay.

Some of the most common indications of fungous infection are: swollen butts, Fig. 2; enlarged areas on the trunks, Fig. 3; the presence of sporophores; and bark cankers. Sporophores do not always form when a trunk is infected. This is well known to be the case in the Heart Rot of the Maple due to *Fomes igniarius.*

Fig. 3. Fomes Everhartii on a Shingle Oak. This is a typical trunk attacking fungus.

b. *Important trunk-attacking species.*

White Heart Rot of Maples—*Fomes igniarius* (L.) Gillet.

This fungus causes a white heart rot of very many species of deciduous trees. I have found the sporophores of this species on the soft maple only. The fungus does not always produce sporophores on infected trees. When these are not present it is practically impossible to recognize diseased trees. The effect on the

wood is very characteristic and can be recognized readily in sawed material. The decayed areas are bounded by a dark zone. This zone is definitely limited on the outside by one or more black layers.

This fungus is reported (1) to attack "more species of broad-leaf trees than any other similar fungus. Among its hosts are to be found the most important timber trees of the deciduous forests of North America."

I have found this species only on the maples. It is quite likely that it attacks other trees in Indiana forests. In New York as high as 90 to 95% of the trees of a single stand were found to be infected by this fungus.

Brown Heart Rot of Oaks—*Fomes Everhartii* Ellis and Galloway.

Probably the most important fungus attacking the oak trees in the state is Fomes Everhartii. This fungus is very common in the northern counties. It attacks various species of oaks. I have found and have reported this species to be especially virulent on the shingle oak (2). Fig. 3 shows a shingle oak attacked by this fungus.

I have also found the fungus on the swamp white, white, black, and red oaks. Fig. 4 shows the fungus on a young swamp white oak in Kosciusko County.

This fungus causes a brown, dry rot in the heartwood. It is one of the most important of the oak heart rots in the Middle States. It is not limited to the oaks alone but is also reported to attack the black and white walnuts (3).

Red Heart Rot of Oaks—*Polyporus sulphureus* (Bull.) Fr.

The heart wood of red oaks especially is attacked by this species. The soft brackets of the fungus are bright yellow to orange in color and grow to large size. The rotted heartwood is of a reddish brown color and cracks much as the decay progresses.

The fungus is common in the State. It is very destructive but with its bright yellow sporophores it can be detected readily in a tree. A tree infected with it should be cut out immediately and all infected wood burned.

White Rot of Oaks—*Hydnum erinaceus* Bull.

The sporophores of this fungus are white and vary in size from ½ to 10 inches. They are made up of white spines upon whose surfaces the spores are borne. The rot caused by this species is

a soft and wet rot with numerous holes full of the white mycelium. It attacks the red and white oaks. Old trees show this rot without having any sporophores develop.

The species is reported frequently in the State, but the extent of its destructiveness is unknown. It causes considerable trouble in Arkansas to the white oak (4).

Piped Rot of the White Oak—*Polyporus pilotæ* Schw.

This fungus has been reported from the southern part of the State by J. M. VanHook (5). The fungus is reported to cause a butt-rot of the oak and chestnut (4). In the vicinity of Delphi, Indiana, I have observed a number of white oaks which had been cut that were heart rotted in the butts only. There were no sporophores by which to identify the cause of the rots but the wood corresponds well with the description of the infected wood given by W. H. Long (4).

The wood shows distinct pockets lined with white cellulose fibres. It is not much unlike the effect of *Stereum frustulosum,* a saprophyte attacking the same kind of wood. This is a character noted in Mr. Long's paper.

A Straw Colored Rot of Oaks—*Polyporus frondosus* Fr.

This fungus is very common in the vicinity of Lafayette. It is reported by VanHook (5). I have never collected this fungus from a living tree, always from a fallen tree or from an old stump. Long (4) describes the rot as a watery reddish discoloration of the wood. The older parts of the rot become light tan in color and the checks in the wood fill up with a slight mycelial weft.

White Heart Rot of Ash—*Fomes fraxinophilus* Peck.

This is the most important fungus attacking ash trees (3). The fungus causes the wood to become soft, spongy and nonresistant. This disease is easily controlled by careful treatment of injuries to young trees. Young, rapidly growing ash trees are unusually susceptible to this disease. Any trees that are found to be infected should be removed and destroyed.

Yellow Heart Rot of the Black Locust—*Fomes rimosus* Berk.

This fungus appears to be rather common within the State. It attacks and causes the yellow rot of the heartwood, completely destroying it. Infection takes place through the channels cut by the Locust Borer (1). The sporophores grow to quite a large size, twelve inches and over.

Heart Rot of the Catalpa—*Polyporus versicolor* Fr.

The catalpas are relatively free of injurious fungi. This fungus is reported to cause a serious heart rot of the catalpa in Kansas (6). I have found the fungus attacking Catalpa speciosa but was unable to ascertain the extent of the decay. It probably was very slight at the time of my observation.

Collybia velutipes Fr. is another fungus attacking the heartwood of the catalpa. I found this fungus growing from a branch scar. Again the injury was very slight. I am of the opinion that

Fig. 4. Fomes Everhartii on a Swamp White Oak. The fungus attacks relatively young trees.

the catalpas of this vicinity are little injured by trunk attacking fungi.

Bark Canker of Soft Maples—*Schizophyllum commune* Fr.

Many of the soft maples that are used in city planting are attacked by this fungus. These trees are usually brought from a nursery where they had been growing in relatively dense stands. When they are isolated the trees unless supported, are subjected to greater wind thrust. I believe the bark is injured in this way and that the fungus enters. The bark is badly cankered and peels off in large plates. The sporophores of this fungus are small,

woolly-white brackets. They usually occur in large numbers over the cankered areas.

Heart Rot of the Beech—*Steccherinum septentrionale* (Fr.) Banker.

This fungus is related to the *Hydnum erinaceus* attacking the oak. It is a shelving species and as a rule, is larger. Its spores are also borne on spines. So far as I know it has been found only on the beech within the State, although it is reported to attack

Fig. 5. Pleurotus ulmarius growing from an incompletely healed scar on an American Elm. By properly painting this wound, this rot could have been prevented.

the maples (1). It attacks the heartwood of the beech but apparently does not do much damage. It has been found in all parts of the State where beech is common.

Elm Pleurotus—*Pleurotus ulmarius* Bull.

This fungus should probably not be described in connection with forest tree fungi. It is most common in cities and towns. At least this is where it is observed most frequently. The fungus is

shown in Fig. 5. The figure shows well the necessity of painting over cut or injured areas. The tree, it will be noticed, had made good growth toward covering over the wound but meanwhile the rot developed before complete healing. Had coal-tar been properly applied it is quite likely that this fungus would not have developed.

The rot caused in this case is not extensive. The heartwood was discolored for some distance from the sporophores. The fungus is reported often. It is probably very common.

White Rot of Maples—*Polyporus squamosus* (Huds.) Fr.

This fungus is collected occasionally from the hard maple in the vicinity of Lafayette. It does not seem to be very abundant in the State. The fungus is slow growing and the injury done by it is possibly very small. It causes a white rot in the heart wood. It can be recognized by its yellowish-brown, scaly upper surface.

GENERAL SUMMARY—TRUNK-ATTACKING FUNGI.

These heart and sapwood rots are practically all wound parasites. The bark of the trees is the natural protection of the trees against these fungi. If the bark is injured in any way a channel is open for infection by some one fungus or another. Prevention of this infection is relatively easy. It consists in covering over any exposed place on the tree with coal-tar or paint.

In the forest, tree surgery is practically impossible. Here, however, the trees should all be frequently inspected. When any infected trees are found they should be removed immediately. When this is impracticable at the time, the trees should be noted and watched. Any sporophores, whether in the form of brackets or fleshy toadstools, growing from any part of the tree should be removed and burned. Later, when possible, the trees should be cut and all decayed wood burned. These recommendations apply in general for all of the above described fungi. (If these directions would be carried out to the letter, many of our now standing woodlots would literally disappear in smoke.)

II. FOLIAGE-ATTACKING FUNGI.

The fungi attacking the foliage of forest trees are relatively few in number. The elms at times are unusually susceptible to the Elm Leaf Spot fungus. The catalpas are attacked by a leaf spot fungus which is reported to be serious in some places. These fungi are more or less periodic in their occurrence, and compared with the insect injuries to the foliage they are of little consequence.

Elm Leaf Spot—*Dothidella ulmea* (Sch.) Ell. and Ever.

Many, small, black, slightly elevated masses of the fungus develop on the leaves of the elm. The fungus kills the leaf tissue. When the infection is severe, premature defoliation occurs.

The fungus is abundant in all parts of the United States. During the summer of 1913 it was especially bad in many parts of this State.

Leaf Spot of Oaks—*Marssonia martini* Sacc. and Ell.

The white and swamp white oaks are commonly attacked by this fungus. I have found the leaves of some swamp white oaks badly attacked. The spots are small, but when infection is severe they cover considerable areas.

Catalpa Leaf Spot—*Phyllosticta Catalpæ* Ell. and Mart.

The catalpas in nurseries in Kosciusko County, during this last summer, 1914, were attacked by this fungus. Many of the leaves were completely spotted. Associated with the Phyllosticta was *Macrosporium Catalpæ* Ell. and Mart. The injury, possibly not immediately serious, certainly altered the normal functioning of the leaves, resulting in lessened growth of the attacked trees.

Leaf Spot of Sycamore—*Stigmina platani* Fcl.

This leaf spot may be a local one in the vicinity of Lafayette. So far as I know it has not been reported elsewhere. The fungus grows in the leaf tissue and produces large, black, floccose masses of spores on the lower surface. The leaves are not badly injured but lose their normal coloring and become a yellowish green.

Hickory Leaf Spot—*Bacterium sp.*

Large dark brown areas develop on the leaves of various species of hickories. This blackening at times is very extensive. The injurious effect possibly is slight. This spotting is supposed to be due to bacteria. The injury is worst toward the latter part of the season.

Maple Leaf Tar Spot—*Rhytisma acerinum* (Pers.) Fr.

This fungus was found on the leaves of soft maple that were attacked by the Cottony Scale. The trees were considerably weakened as was manifest by the pale yellowish green foliage and reduced leaves. One of the trees was cankered by the fungus *Nectria cinnabarina* (Tode) Fr.

Mildews—*Erysiphæ species.*

a. *Microsphæra Alni* (Wallr.) Wint.

The young leaves of coppice growth of red and white oaks are often attacked by this mildew. The leaves are sometimes completely covered with the cob-webby mycelium. Some of the leaves are atrophied. I have also found this same species attacking the leaves of the honey locust. The injury was of no apparent consequence.

b. *Uncinula salicis* (DeC.) Wint.

This is the mildew attacking the leaves of the willows. Frequently entire trees appear covered with this white fungus. It is worst at the end of the season and little injury is done.

c. *Phyllactinia Corylea* (Pers.) Karst.

I have collected this fungus on the leaves of the white walnut and the sycamore. In the former case the tree was weakened by having part of its root system exposed by erosion.

In general the mildews are of little concern. They, so far as I have learned, have not been reported to be especially destructive to any trees within the State. If mildews do occur on nursery stock they can easily be controlled by dusting flowers of sulphur over the leaves and young twigs.

Rusts—*Uredineæ species.*

The leaves of poplars and willows are infected by several species of rusts. The Carolina poplar is frequently attacked by *Melampsora Medusæ* Thüm. This is a yellow to orange colored fungus which appears as dusty spots on the foliage. In some seasons, under favorable conditions for the rust, the trees may be defoliated. Ordinarily, the rust is of little importance.

The most important rust attacking the willows is *Melampsora Bigelowii* Thüm. This is also a yellow rust on the leaves.

SUMMARY—FOLIAGE-ATTACKING FUNGI.

The injuries, due to fungi, to the foliage of the forest trees are of so much less importance than those due to insects that they are insignificant. The trees which are attacked by fungi also have serious insect enemies. Any control measures used for either would largely consist in spraying. The spray used should be both a fungicide and an insecticide.

The leaves from infected trees should be gathered and burned. They contain or hold the spores which will reinfect the trees the following season.

III. ROOT-ATTACKING FUNGI.

There are three root-rotting fungi that I shall include in this report.

Root Rot of Oaks—*Polyporus dryadeus* Fr.

This fungus has been collected in the southern part of the State by Van Hook (5). I have found but one specimen on the root of a white oak, near Lafayette. The root was badly rotted. The fungus is reported to be often responsible for the weakening of oak trees that are wind-thrown (7). The fungus grows only in those parts underground. The disease does not seem to spread readily to adjacent trees. It is widely distributed in the United States.

Root Rot of Hickory and Oaks—*Armillaria mellæ* Vahl.

The roots of the trees of both these families are attacked by this Honey Cap fungus. The fungus is very common on dead stumps of oaks, and less common on hickory. It is reported (8) to have caused the death of 21% of the chestnut trees, and 27% of the oaks in a forest stand in New York State.

The fungus infects trees by developing mycelial "roots" which grow underground. These strands grow through the soil and attack the roots from adjacent trees. It is suggested that old stumps which are infected by this fungus may be infection centers for younger trees in their immediate vicinity. I believe that this fungus attacks the trees only when they are considerably weakened.

Root Rot of Oak—*Polyporus Berkeleyi* Fr.

This fungus causes the string and ray rot of oaks as described by Long (4). I have made several collections of it in the vicinity of Lafayette. Van Hook also reports it near Bloomington (5). The fungus is frequently found in Ohio (9).

This fungus is easily recognized by its large size and by its long stem which grows from the ground but which is attached to the roots of the tree. The fungus has a strong, pleasant odor. The effect on the root is to rot it completely inside so that later it becomes hollow.

SUMMARY—ROOT-ROTTING FUNGI.

As mentioned in the beginning of this paper, I believe that the overturning of many trees is due to the action of some of these fungi in destroying the roots. I believe them to be especially responsible when the roots, or parts of them, are pulled up when the tree falls.

REFERENCES CITED.

1. H. VonSchrenk. Diseases of Deciduous Forest Trees. Bullt. No. 149, Bureau of Plant Industry.
2. G. N. Hoffer. Pyropolyporus Everhartii (Ell. and Gall.) Murrill as a Wound Parasite. Proc. Indiana Acad. of Science, 1913.
3. G. G. Hedgecock. Notes on Some Diseases of Trees in Our National Forests. Phytopathology, Vol. II, No. 2, 1912.
4. W. H. Long. The Undescribed Heart Rots of Hardwood Trees, especially of Oak. Jour. Agricultural Research, Vol. 1, No. 2. 1913.
5. J. M. VanHook. Indiana Fungi. Proc. Ind. Acad. Science, 1910.
6. Neil E. Stevens. Wood Rots of the Hardy Catalpa. Phytopathology, Vol. II, No. 3. 1912.
7. W. H. Long. Polyporus dryadeus, a Root Parasite on the Oak. Jour. Agricultural Research, Vol. I, No. 3, 1913.
8. W. H. Long. Death of Chestnuts and Oaks. Bullt. 89. U. S. Dept. of Agriculture. 1914.
9. L. M. Overholts. The Polyporaceæ of Ohio. Annals of Mo. Bot. Garden, 1:81-155. March 1914.

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